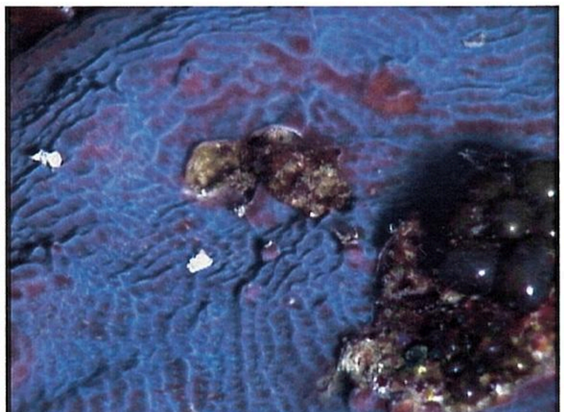
Final Report to The National Oceanic and Atmospheric Administration
Coral Reef Conservation Grant Program

Project Title: *NOAA CRCG 2002 Habitat Characterization of Pulley Ridge and the Florida Middle Grounds*

Part II: *Characterization of The Pulley Ridge Coral and Fish Fauna*



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Preface

Pulley Ridge is a 100+ km-long series of north-south trending drowned barrier islands on the southwest Florida Shelf approximately 250 km west of Cape Sable, Florida (*Figure 1*). The ridge has been mapped using multibeam bathymetry, submarines and remotely operated vehicles, and a variety of geophysical tools. The ridge is a subtle feature about 5 km across with less than 10 m of relief. The shallowest parts of the ridge are about 60 m deep. Surprisingly at this depth, the southern portion of the ridge hosts an unusual variety of zooxanthellate scleractinian corals, green, red and brown macro algae, and typically shallow-water tropical fishes.

The corals *Agaricia* sp. and *Leptoceris cucullata* are most abundant, and are deeply pigmented in shades of tan-brown and blue-purple, respectively. These corals form plates up to 50 cm in diameter and account for up to 60% live coral cover at some localities. Less common species include *Montastrea cavernosa, Madracis formosa*, *M. decactis*, *Porities divaricata*, and *Oculina tellena*. Sponges, calcareous and fleshy algae, octocorals, and sediment occupy surfaces between the corals. Coralline algae appear to be producing as much or more sediment than corals, and coralline algal nodule and cobble zones surround much of the ridge in deeper water (greater than 80 m).

In addition to coralline algae other abundant macro algae include *Halimeda tuna*, *Lobophora variegata, Ventricaria ventricosa, Verdigelas peltata, Dictyota* sp., *Kallymenia* sp., and particularly striking fields of *Andaymonene menzeii*. The latter algae covers many hectares at densities of tens of individuals per square meter, constructing regions that appear like lettuce fields growing in the dusk at this depth on the sea floor.

The fishes of Pulley ridge comprise a mixture of shallow water and deep species sharing this unusual habitat. More than 60 species have been identified. Commercial species include *Epinephelus morio* (red grouper) and *Mycteroperca phenax* (scamp). Typical shallow-water tropical species include *Thalassoma bifasciatum* (bluehead), *Stegastes partitus* (bicolor damselfish), *Cephalopholis fulva* (coney), *Lachnolaimus maximus* (hogfish), *Pomacanthus paru* (French angelfish), and *Holacanthus tricolor* (rock beauty). The deepwater fauna is represented by *Chaetodon aya* (bank butterflyfish), *Sargocentron bullisi* (deepwater squirrelfish), *Bodianus pulchellus* (spotfin hogfish), *Pronotogrammus martinicensis* (roughtongue bass), and *Liopropoma eukrines* (wrasse bass). *Malacanthus plumieri* (sand tilefish) and several other species construct large burrows and mounds that serve as refuge for multiple species. Mounds and pits larger than 1m^2 are apparent on side-scan sonar images and have been counted in excess of 200/km^2 for parts of the ridge.

The extent of algal cover and abundance of herbivores suggest benthic productivity is moderate to high on parts of the ridge. Such productivity is unusual, if not unique at this depth in the Gulf of Mexico and Caribbean. Several factors help to account for the existence of this community. First, the underlying drowned barrier islands provided both elevated topography and lithified substrate for the hard bottom community that now occupies the southern ridge. Second, the region is dominated by the western edge of the Loop Current that brings relatively clear and warm water to the southern ridge. Third, the ridge is within the thermocline, a water mass that is known to provide nutrients during upwelling to shallow reefs in Florida.

Notwithstanding the positive factors for reef growth listed above, this largely photosynthetic community appears to be thriving on 1-2% (5-30 microEinsteins/m^2/sec) of the available surface light (PAR) and about 5% of the light typically available to shallow-water reefs (500 – 1000 microEinsteins/m^2/sec) *(Figure 3)*. The corals generally appear to be healthy, with no obvious evidence of coral bleaching or disease. Although the community is clearly one adapted to low light conditions, the variety and extent of photosynthetic organisms between 60 and 70 meters depth is impressive.

Is southern Pulley Ridge the US's deepest coral reef? That depends, of course, on one's preferred definition of a coral reef. There are deeper, ahermatypic coral buildups both in the Gulf of Mexico and Atlantic off Florida coasts. Classically, a coral reef is a wave resistant structure built by hermatypic corals and hazardous to shipping. From a geologist's point of view, Pulley Ridge corals appear to have built a biostrome, an accumulation at least a few meters thick, although corals may not account for the bulk of the topography. From that of a biologist, the most abundant corals in the ridge are hermatypic corals but they are lying, mostly unattached, on the surface. Clearly a ship's captain could not run his vessel aground on this reef, so mariners would not consider this a reef. Nevertheless, from the scientific perspective of a structure built from hermatypic corals, southern Pulley Ridge may well be the deepest coral reef in the United States.

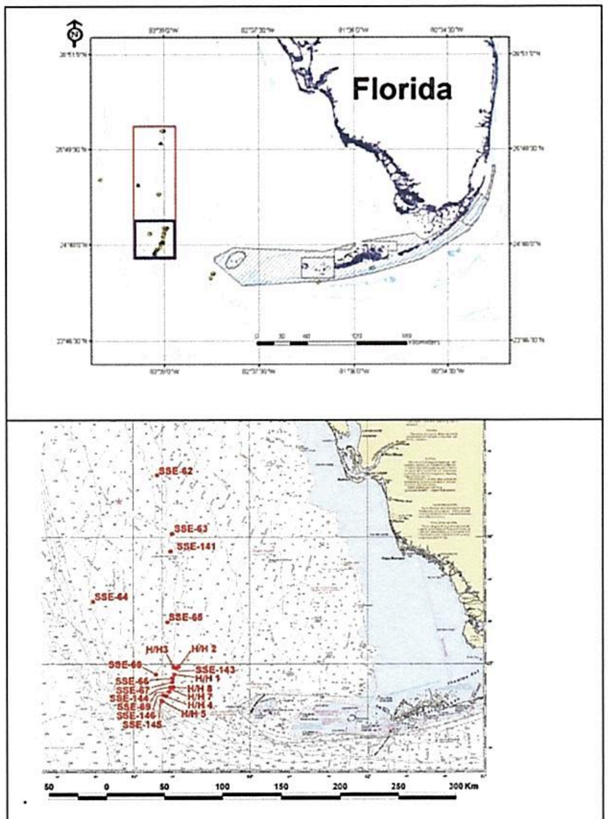

Figure 1. *A.* Southwest Florida shelf. Pulley Ridge indicated by boxes. The bottom box indicates area containing coral habitat. B. Submersible (SSE) & ROV (H/H) sampling sites with dive number on the (Adapted from NOAA Chart 11006S).

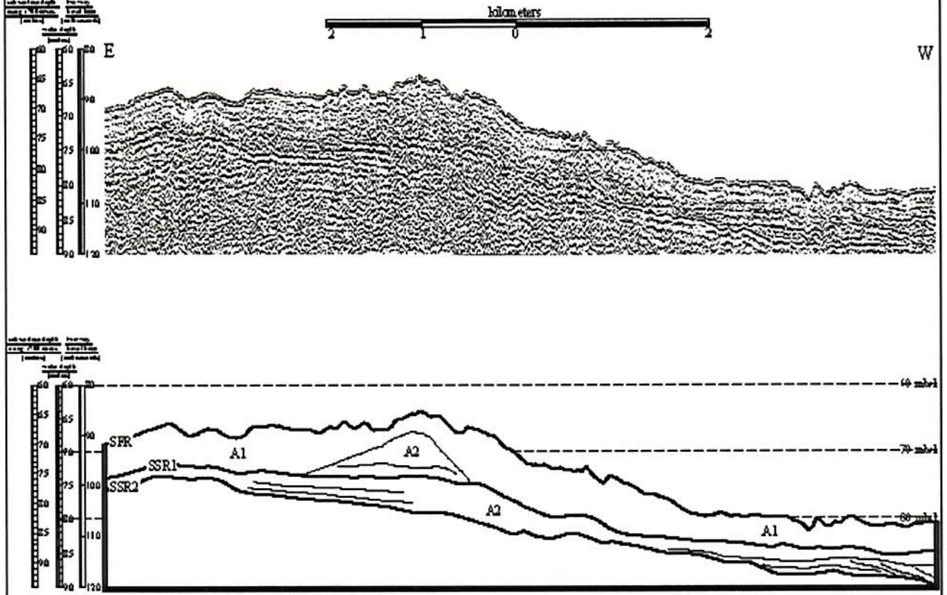

Figure 2 Seismic section across Pulley Ridge

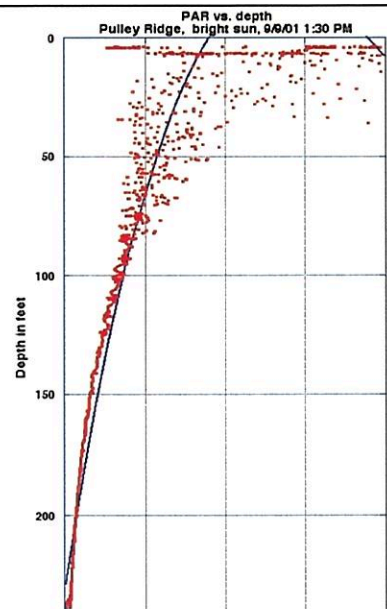

Figure 3. Light profile of Pulley Ridge

Reef Fish Assemblages of Shelf-edge Features on the Southwest Florida Shelf

By
George P. Dennis and Doug Weaver

Introduction

The southwest Florida shelf is unique in the Gulf of Mexico as it is primarily carbonate in origin and has tropical water temperatures. This suggests that the tropical fauna known from the Dry Tortugas at the southern edge of the shelf may extend into the Gulf of Mexico. While a tropical affinity fish fauna is now well recognized on hard bottom features through the Gulf at northern locations the fauna is typically depauperate due to the limited habitat and suboptimal environmental conditions (Smith 1976; Dennis & Bright,1988; Rezak et al. 1990).

The southern end of the southwest Florida shelf was first explored biologically by the *Blake* in 1869 (Agassiz 888). Fishery exploration in 1885 identified red snapper resources in this area (Collins 1885) and further exploration in 1891 concluded that substantial unexploited snapper resources occurred in the area (Adams and Kendall, 1891). Red snapper are primarily found in the hard bottom biotope. This indicated to biologists that hard bottom must be present on the southwest Florida shelf (Camber, 1955). Geological surveys in the 1950s mapped the bottom revealing the rough nature of the shelf and found topographic features along the shelf edge (Jordan and Stewart, 1959; Jordan et al., 1964). By the 1960s when Moe (1963) reviewed fishing grounds off Florida the southwest Florida shelf was an important grouper fishing area targeting the red grouper (*Epinephelus morio*). The grouper fishery developed and had a substantial Cuba component until the Fishery Conservation Zone went into effect in 1977 and excluded the Cuban fleet (Tashiro & Coleman 1977). The present-day fishery is still substantial (Schirppia et al. 1999).

Holmes (1985) provided a model for development of the south Florida shelf platform from further geological research in the area and found the presence of coralline algae on middle and outer shelf features. It was not until the mid-1980s that the area was extensively surveyed and benthic communities described in the Minerals Management Service (MMS) Southwest Florida Shelf Ecosystems System (Phillips et al. 1990). This study first identified substantial areas of algal nodules and deep-water coral reef communities in the area known as Pulley Ridge (Figure 1). More recent exploration has focused on examining these deep-water coral reef and algal-nodule communities in more detail (Jarrett et al., 2000). Here we describe the reef fish assemblages found on shelf-edge topographic features of the southwest Florida shelf.

Study Area

The southwest Florida shelf differs from the Gulf of Mexico continental shelf farther north in being primarily carbonate in origin and having the highest proportion of hard bottom habitat along the S. E. U.S. and Gulf of Mexico coasts and the smallest proportion of high relief (>1 m) habitat (Parker et al., 1983). Much of the hard bottom is very low relief and in many areas covered by a thin veneer of sand (Phillips et al. 1990).

Well-developed epibenthos assemblages occur on this low relief hard bottom and in algal-nodule areas. Pulley Ridge is a topographical feature running north-south along the shelf-edge that was forming during a previous low sea level stand (Holmes 1985). The ridge rises from 65 m to 60 m at the crest and then drops off gradually to 160 m. The southern end of the Ridge has a cemented algal nodules cap that is colonized by hermatypic coral (primarily *Agaricia* spp.) and macroalgae, both crustose (*Peyssonnelia* spp.) and leafy green (*Anadyomene menziesii*) (Phillips et al. 1990). Farther north along the Ridge the hermatypic coral disappears leaving just an algal nodule and leafy algae community. The ridge has been mapped by high-resolution seismic reflection profiling and multibeam sonar (Jarrett et al. 2000).

An additional topographic feature, Howell Hook, occurs on the outer shelf at 120-160 m (Holmes 1985). The epifauna in this area is characterized by a deep-water assemblage including antipatharians, azooxanthellate gorgonians, crinoids, and ahermatypic corals (Phillips et al. 1990).

Methods

Characteriztion of the bottom-dwelling fish fauna is based on data from from 21 sites along the middle and outer southwest Florida shelf (Figure 1), including 13 submersible dives (2000, 2001) and eight ROV dives (2001, using the National Undersea Research Center/ University of North Carolina-Wilmington Phantom S2 mini-ROV) made during Sustainable Seas Expeditions (SSE) (Table 1).

The submersible video tapes were not encoded with the time. Because of frequent time code breaks in the video record, video and navigation data could not be correlated. Thus no estimate of bottom area surveyed could be made. Although ROV tapes were time coded, we standardized data collected from the submersible and ROV tapes for fish identification, enumeration, and quantification by hour of video time.

Because each dive had multiple objectives, not all video footage was adequate for fish analysis. Only footage where the bottom was adequately illuminated and the camera angle-of-view narrow enough to identify fish was used in the analysis. This includes both transiting and stationary periods so these results can be considered a combination of transect and point count data.

Scientific names for fishes follow Eschmeyer et al. (2003); common names are from Robins et al. (1991). Fish distribution among sites was explored using cluster analysis. The Sorenson similarity measure and flexible sorting linkage method were used to construct the clusters (Boesch 1977). Rare taxa occuring at fewer than three sites were removed from the dataset to reduce potential bias from chance occurrences and poor sampling. Clustering was followed by indicator species analysis to determine the appropriate clustering level and identify taxa that characterized each cluster group. Indicator species are defined as the most characteristic taxa for a group (Dufrêne and Legendre 1997). Starting at the five cluster level cluster groups at that level and higher were compared using the sum of the indicator values. The maximum in sum of significant indicator values was used as a measure of the appropriate clustering level to interpret the data. Clusters below this level do not provide further substantive information on the relationship among sites. The indicator value for each taxon was evaluated for statistical significance by Monte Carlo test.

Only those taxa with a probability level > 0.05 were considered significant indicators of a group. We used the PC-ORD program for these analyses (McCune and Mefford, 1999).

Four community parameter components, diversity, evenness, species richness, and overall abundance, were estimated for each site and compared among cluster groups. The Shannon-Weiner function (H') was used to estimate site diversity. Evennness was estimated as $H'/\log_e s$ where s is the total number of taxa at a site (Pielou, 1977). The number of taxa and total number of individuals were divided by number of survey hours to adjust for the differences in sampling effort. The number of taxa per survey hour was used as a measure of species richness and the number of individual per survey hour a measure of overall abundance.

Table 1. Dates & dive times (local time) for submersible (SSE) and ROV (H/H) dives used to characterize the reef fish assemblages on the shelf-edge features of the SW Florida shelf. Survey time & total video time (in hrs) are listed by dive. Latitude & Longitude are the starting location for each dive; maximum depth attained in meters.

		Time (LT)		Survey	Video	Location		Maximum
Dive No.	**Date**	**Start**	**End**	**Hours**	**Hours**	**Latitude**	**Longitude**	**Depth (m)**
SSE-62	25-Aug-2000	9:30	12:30	1.65	2.88	26.4845	-83.7916	82
SSE-63	25-Aug-2000	22:23	1:05	0.88	2.25	26.0270	-83.6627	72
SSE-64	26-Aug-2000	13:24	16:29	1.16	2.76	25.4965	-84.3500	180
SSE-65	26-Aug-2000	22:29	1:17	0.32	1.11	25.3322	-83.7074	86
SSE-66	28-Aug-2000	13:26	16:01	1.06	2.22	24.8869	-83.6611	69
SSE-67	28-Aug-2000	18:56	22:24	0.83	3.12	24.8573	-83.6628	65
SSE-68	29-Aug-2000	13:02	15:46	0.12	0.99	24.9166	-83.8043	92
SSE-69	29-Aug-2000	22:38	1:13	1.15	2.24	24.7801	-83.6907	67
SSE-141	28-Jun-2001	15:12	17:42	0.64	0.94	25.8890	-83.6774	100
SSE-143	29-Jun-2001	13:27	17:39	1.73	3.96	24.9663	-83.6351	84
SSE-144	29-Jun-2001	20:48	2:09	2.95	3.93	24.8153	-83.6825	85
SSE-145	30-Jun-2001	13:45	17:45	1.14	2.34	24.7087	-83.7571	114
SSE-146	30-Jun-2001	19:58	0:05	1.50	1.98	24.7523	-83.7373	123
H/H 1	8-Sep-2001	8:50	12:31	1.46	3.60	24.9172	-83.6449	72
H/H 2	8-Sep-2001	14:00	16:00	1.66	1.94	24.9761	-83.6118	76
H/H 3	8-Sep-2001	16:55	17:52	0.42	0.96	24.9763	-83.6536	52
H/H 4	9-Sep-2001	8:20	10:20	1.69	2.00	24.7458	-83.7159	71
H/H 5	9-Sep-2001	11:15	13:14	1.05	1.97	24.7045	-83.7520	108
H/H 6	9-Sep-2001	14:15	18:11	2.25	3.77	24.7044	-83.7532	178
H/H 7	10-Sep-2001	9:05	12:05	1.36	2.99	24.8098	-83.6752	42
H/H 8	10-Sep-2001	13:30	17:30	2.38	3.91	24.8174	-83.6557	72

Results

More than 51 hours of underwater video from submersible and ROV dives were reviewed for fish observations. Only 53% (27.4 hours) of the video was usable for fish analysis due the poor lighting and inadequate viewing angle. The small size (<10 cm) of most reef fishes requires the video platform to remain near bottom and the video camera to be set at a medium or normal angle of view to adequately view and identify fishes. Despite these limitation 121 taxa were identified from the submersible and ROV video in this study (Table 2). About 43% (52) of these taxa were only observed at one site. Eleven taxa were only observed during periods outside the survey time when the video camera was close focused or oriented vertically. The top five taxa are made up of bottom-associated aggregating species such as, *Schultzea beta*, anthiines, *Pronotogrammus martinicensis*, *Serranus tortugarum*, and *Haemulon striatum*. The next five most common taxa are a mixture of aggregating species, such as bottom-associated *Chromis enchrysura*, *Chromis scotti*, and mixed aggregations of *Chromis* spp. and the pelagic taxa, *Decapterus* spp. The later was one of the top 10 taxa in abundance, but only had a limited distribution. They are typically found in the water column during the day and are more bottom oriented during the crepuscular and nocturnal periods making them susceptible to the video sampling method. All fish taxa observed are listed by site in Appendix Table A-1.

Previous scientific studies during the MMS Southwest Florida Ecosystem Study included several sites on the middle and outer southwest Florida shelf. Fishes observed and collected in this study are summarized in Appendix Table B-1. Six taxa were observed during the MMS video surveys, but not reported here (Table 3). Other gears, such as otter trawl and triangle dredge, collected many cryptic taxa and specimens to help confirm the visual identification from the video surveys (Appendix Table B-1).

Table 2. Fish taxa observed in video footage at 21 sites on the southwest Florida shelf listed by alphabetically by family and species. The total number of individuals, overall rank for top 20 taxa, and frequency of occurrence are given for each taxon. "P" indicates presence outside of survey time.

Family	Taxon	Common Name	Total No.	Rank	Freq.
Apogonidae	*Apogon affinis*	bigtooth cardinalfish	114	**14**	3
	Apogon pseudomaculatus	twospot cardinalfish	25		10
	Apogon spp.	cardinalfish	6		3
Aulostomidae	*Aulostomus maculatus*	trumpetfish	1		2
Balistidae	*Balistes capriscus*	gray triggerfish	1		1
	Balistes vetula	queen triggerfish	P		1
	Xanthichthys ringens	sargassum triggerfish	1		1
Batrachoididae	*Opsanus pardus*	leopard toadfish	1		1
Caproidae	*Antigonia capros*	deepbody boarfish	10		2
Carangidae	Carangidae	jacks	27		1
	Decapterus spp.	scads	254	**8**	2
	Seriola dumerili	greater amberjack	P		1
	Seriola rivoliana	Almaco jack	30		4
Carcharhinidae	Carcharhinidae	requiem shark	3		2
Chaetodontidae	*Chaetodon ocellatus*	spotfin butterflyfish	2		1
	Chaetodon sedentarius	reef butterflyfish	164	**12**	17
	Prognathodes aculeatus	longsnout butterflyfish	10		3
	Prognathodes aya	bank butterflyfish	22		5
	Prognathodes guyanensis	French butterflyfish	1		1
Clupeidae		herrings	14		1
Diodontidae	*Diodon holocanthus*	balloonfish	3		3
Engraulidae	Engraulidae	anchovies	P		1
Ginglymostomatidae	*Gingylostoma cirratum*	nurse shark	1		1
Gobiidae	Gobiidae	gobies	16		5
Haemulidae	*Haemulon melanurum*	cottonwick	3		1
	Haemulon striatum	striped grunt	816	**5**	9
	Haemulon spp.	grunts	1		1
Holocentridae	*Corniger spinosus*	spinycheek soldierfish	7		2
	Holocentrus adscensionis	squirrelfish	16		5
	Holocentrus rufus	longspine squirrelfish	3		3
	Holocentridae	squirrelfish	4		4
	Myrpristis jacobus	blackbar soliderfish	P		1
	Neoniphon marinus	squirrelfish	6		2

Table 2. Continued.

Family	Taxon	Common Name	Total No.	Rank	Freq.
Holocentridae	*Ostichthys trachypoma*	bigeye soldierfish	8		1
(continued)	*Sargocentron bullisi*	deepwater squirrelfish	43		14
Inermiidae	Inermiidae	boga	75	**17**	1
Labridae	*Bodianus pulchellus*	spotfin hogfish	21		11
	Decodon puellaris	red hogfish	22		6
	Halichoeres bathyphilus	deepwater wrasse	63	**20**	10
	Halichoeres garnoti	yellowhead wrasse	2		2
	Halichoeres sp.	wrasse	4		4
	Labrid	unidentified wrasse	1		1
	Lachnolaimus maximus	hogfish	8		6
	Xyrichthys spp.	razorfish	1		1
Lutjanidae	*Lutjanus* sp.	snapper	5		2
	Lutjanus analis	mutton snapper	1		1
	Lutjanus campechanus	red snapper	12		5
	Lutjanus jocu	dog snapper	2		1
	Rhomboplites aurorubens	vermilion snapper	84	**16**	3
Malacanthidae	*Caulolatilus cyanops*	blackline tilefish	P		1
	Caulolatilus microps	blueline tilefish	1		1
	Malacanthus plumieri	sand tilefish	7		6
Monacanthidae	*Monacanthus ciliatus*	fringed filefish	1		1
	Monacanthus tuckeri	slender filefish	2		2
Mullidae	*Pseudupeneus maculatus*	spotted goatfish	3		3
Muraenidae	*Gymnothorax moringa*	spotted moray	2		2
	Muraena retifera	reticulate moray	1		1
	Muraenidae	moray	1		1
Ogoccephalidae	*Ogcocephalus* spp.	batfish	1		1
Ophichthidae	*Ophichthus ophis*	spotted snake eel	1		1
Ostraciidae	*Acanthostracion* spp.	cowfish	4		3
Peristediidae	*Peristedion* spp.	armored searobins	1		1
Pomacanthidae	*Centropyge argi*	cherubfish	176	**11**	12
	Holacanthus bermudensis	blue angelfish	16		7
	Holacanthus tricolor	rock beauty	36		10
	Pomacanthus arcuatus	gray angelfish	P		1
	Pomacanthus paru	French angelfish	P		1

Table 2. Continued.

Family	Taxon	Common Name	Total No.	Rank	Freq.
Pomacentridae	*Chromis cyanea*	blue chromis	33		4
	Chromis enchrysura	yellowtail reeffish	739	**6**	15
	Chromis insolata	sunshinefish	134	**13**	8
	Chromis scotti	purple reeffish	470	**7**	13
	Chromis spp.	damselfishes	184	**10**	4
	Stegastes partitus	bicolor damselfish	215	**9**	11
Priacanthidae	*Pristigenys alta*	short bigeye	19		5
	Priacanthus arenatus	bigeye	3		3
Rajidae	Rajidae	skate	1		1
Scaridae	*Cryptotomus roseus*	slender parrtotfish	1		1
Scaridae	*Sparisoma atomarium*	greenblotch parrotfish	68	**18**	13
Sciaenidae	*Equetus lanceolatus*	jack-knife fish	49		4
	Pareques iwamoto	black-bar drum	2		1
	Pareques umbrosus	cubbyu	65	**19**	1
Scorpaenidae	Scorpaenidae	scorpionfishes	5		4
Serranidae	*Anthias tenuis*	threadnose bass	P		2
	Anthiins	slender anthiins	2024	**2**	7
	Cephalopholis cruentata	graysby	5		4
	Cephalopholis fulva	coney	1		1
	Epinephelus adscensionis	rock hind	1		1
	Epinephelus drummondhayi	speckled hind	5		2
	Epinephelus guttatus	red hind	P		1
	Epinephelus morio	red grouper	12		11
	Epinephelus nigritus	Warsaw grouper	1		1
	Epinephelus niveatus	snowy grouper	2		1
	Epinephelus spp.	groupers	1		1
	Gonioplectrus hispanus	Spanish flag	6		1
	Hemanthias aureorubens	streamer bass	P		1
	Hemanthias vivanus	red barbier	P		3
	Liopropoma aberrans	rosy basslet	P		1
	Liopropoma eukrines	wrasse bass	40		17
	Liopropoma sp.	basslet	1		1
	Mycteroperca intertitialis	yellowmouth grouper	3		2
	Mycteroperca microlepis	gag	1		1
	Mycteroperca phenax	scamp	50		8
	Mycteroperca spp.	grouper	17		4
	Paranthias furcifier	creole-fish	17		4

Table 2. Continued.

Family	Taxon	Common Name	Total No.	Rank	Freq.
Serranidae	*Plectranthias garrupellus*	apricot bass	7		1
(continued)	*Pronotogrammus martinicensis*	roughtongue bass	978	**3**	6
	Schultzea beta	school bass	3015	**1**	6
	Serranus annularis	orangeback bass	95	**15**	13
	Serranus notospilus	saddle bass	1		1
	Serranus phoebe	tattler	53		14
	Serranus tigrinus	harlequin bass	2		1
	Serranus tortugarum	chalk bass	817	**4**	10
Sparidae	*Calamus* spp.	porgy	4		3
	Pagrus pagrus	red porgy	2		1
Sphyraenidae	*Sphyaena barracuda*	greater barracuda	6		6
Synodontidae	*Synodus* spp.	lizardfishes	12		5
Tetraodontidae	*Canthigaster jamestyleri*	sharpnose puffer	3		2
	Canthigaster rostrata	Atlantic sharpnose puffer	21		6
	Canthigaster spp.	sharpnose puffer	6		1
	Sphoeroides spengleri	bandtail puffer	2		1
Triglidae	*Prionotus* spp.	sea robin	1		1

Total Number of Individuals	11367
Total Number of Taxa	121

Table 3. Taxa identified from video surveys during the MMS South Florida Ecosystem Study, but not reported here.

Family	Taxon	Common Name
Labridae	*Halichoeres caudalis*	painted wrasse
Pomacanthidae	*Holacanthus ciliaris*	queen angelfish
Pomacentridae	*Stegastes variabilis*	cocoa damselfish
Priacanthidae	*Heteropriacanthus cruentatus*	glasseye snapper
Serranidae	*Hypoplectrus* spp.	hamlets
Serranidae	*Serranus atrobranchus*	blackear bass

Cluster Analysis

Fifty-four taxa, found at three sites or more, were used in the cluster analysis (Table 4). The relationship among sites is displayed in Figure 2. To determine the appropriate cluster level to interpret, the indicator values (IVs) at each cluster level were examined. A maximum in the sum of significant IVs indicates the optimum division of the taxa among sites. The sum of IVs was maximum at the three-cluster level. Examination of the indicator values for taxa at the three-cluster level shows ten taxa as significant indicators for cluster group 1 and five taxa defined cluster group 3 (Table 4). Cluster group 3 represents a deep-water (>80 m) outer-shelf assemblage indicated by the importance of anthiins, *P. martinicensis*, and *Prognathodes aya*. All sites with these taxa are in cluster group 3. This cluster group had low diversity and evenness, but a high overall mean abundance due to the large schools of anthiins (Table 5).

Cluster group 1 consists of a middle shelf (<80 m) assemblage of taxa found at most sites on the top of Pulley Ridge characterized by *Centropyge argi*, *C. enchrysura*, *C. scotti*, *Sargocentron bullisi*, *Serranus annularis*, and *Sparisoma atomarium*. Three sites deeper than 80 m were misclassified in cluster group 1. All were characterized by the lack of anthiins and *P. martinicensis.* SSE 143, SSE-144, and SSE-146, are unique in having well developed algal-nodule communities with dominant taxa, such as *C. enchrysura* and *S. tortugarum*, characteristic of cluster group 1, but being deeper than average. The sites in cluster group 1 had the highest mean overall abundance due to the large numbers of *S. beta* and *S. tortugarum* (Table 5). The dominance of bottom-aggregating taxa resulted in moderate diversity and evenness values.

Cluster group 2 is a combination of shallow sites that lacked algal nodules and deep sites that were poorly sampled. The lack of dominant taxa at these sites results in the highest diversity and evenness in this cluster group (Table 5).

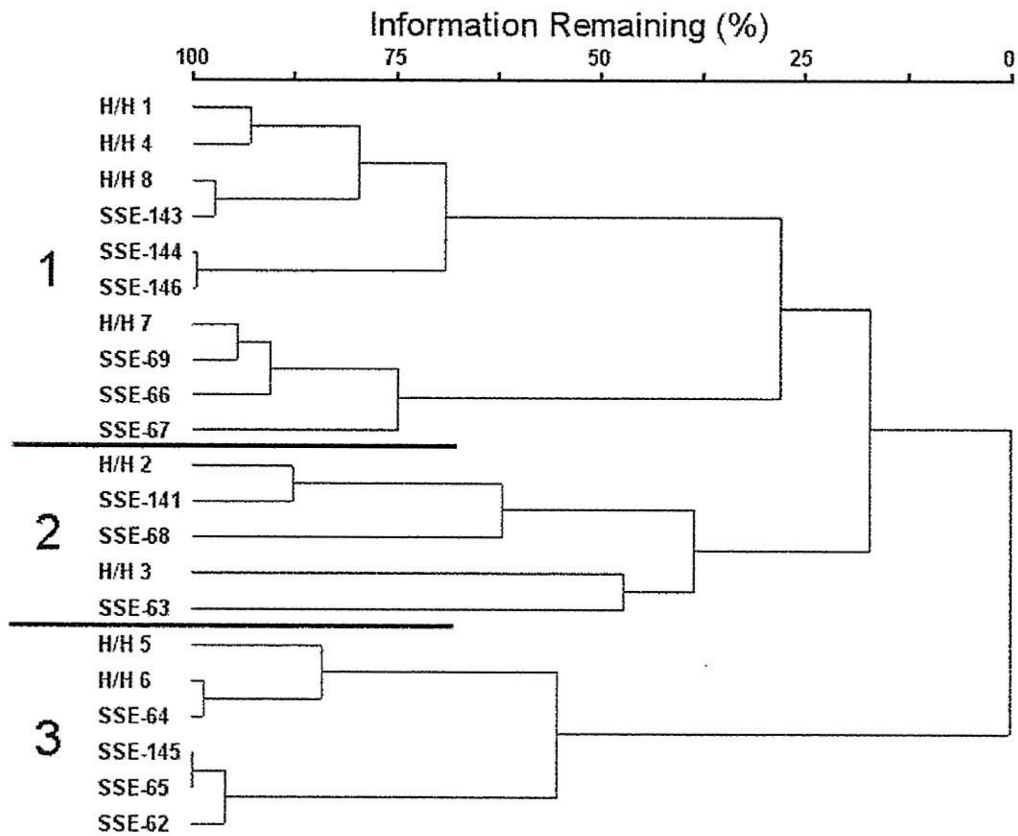

Figure 2. Cluster diagram of sites based on 54 common fish taxa using Sorenson similarity measure and flexible sorting.

Table 4. Alphabetical list of the 54 taxa used in the cluster and indicator species analyses. Maximum group indicates the cluster group that had the maximum indicator value and observed indicator value (IV) for this cluster. Monte Carlo estimates of the mean indicator value for randomized groups and the standard deviation (SD) are used to determine the probability (P) that the observed value is greater than expected by chance alone for each taxon. Significant values (P<0.05) marked in bold.

			Randomized Groups		
Taxon	**Maximum Group**	**Observed IV**	**IV Mean**	**SD**	**P**
Acanthostracion spp.	2	25.9	18.0	9.8	0.295
Anthiins	3	99.4	28.0	12.4	**0.001**
Apogon affinis	1	19.7	22.1	9.5	0.633
Apogon pseudomaculatus	3	16.6	35.2	12.6	0.988
Apogon spp.	2	27.1	17.8	10.4	0.256
Bodianus pulchellus	1	31.9	33.7	10.9	0.489
Calamus spp.	2	11.2	18.2	10.5	0.623
Canthigaster rostrata	3	27.3	30.4	13.0	0.548
Centropyge argi	1	97.4	36.5	11.6	**0.001**
Cephalopholis cruentata	3	16.4	20.1	10.0	0.559
Chaetodon sedentarius	1	33.4	41.3	8.7	0.833
Chromis cyanea	1	40.0	26.4	11.8	0.108
Chromis enchrysura	1	58.7	39.8	9.9	**0.044**
Chromis insolata	2	33.1	36.6	13.8	0.550
Chromis scotti	1	75.1	39.0	11.7	**0.008**
Chromis spp.	2	14.5	22.6	10.8	0.727
Decodon puellaris	3	40.9	25.4	11.3	0.107
Diodon holocanthus	1	30.0	16.9	9.8	0.165
Epinephelus morio	2	32.1	32.8	9.8	0.444
Equetus lanceolatus	2	36.1	21.8	11.6	0.116
Gobiidae	2	36.3	28.3	12.3	0.241
Haemulon striatum	1	65.1	40.3	14.4	0.061
Halichoeres garnoti	2	32.5	34.4	12.5	0.469
Halichoeres sp.	2	26.6	20.6	10.6	0.188
Holacanthus bermudensis	3	11.8	18.9	9.9	0.862
Holacanthus tricolor	1	82.2	31.9	10.4	**0.002**
Holocentrus adscensionis	3	16.7	22.7	10.4	0.721
Holocentridae	3	22.7	28.4	11.5	0.652
Holocentrus rufus	3	20.6	20.6	10.9	0.413

Table 4. Continued.

Taxon	**Maximum Group**	**Observed IV**	**Randomized Groups IV Mean**	**SD**	**P**
Lachnolaimus maximus	2	8.8	25.6	11.6	1.000
Liopropoma eukrines	2	43.3	40.7	8.3	0.320
Lutjanus campechanus	3	16.5	23.3	11.0	0.733
Malacanthus plumieri	1	18.6	26.8	11.9	0.730
Mycteroperca phenax	3	80.8	31.1	12.5	**0.003**
Mycteroperca spp.	3	48.5	25.0	11.6	**0.046**
Paranthias furcifier	3	28.9	21.0	11.2	0.234
Priacanthus arenatus	2	12.1	19.5	9.9	0.675
Pristigenys alta	2	29.4	22.9	11.0	0.199
Prognathodes aculeatus	1	30.0	19.0	9.5	0.212
Prognathodes aya	3	83.3	23.0	11.3	**0.001**
Pronotogrammus martinicensis	3	100.0	25.3	11.5	**0.001**
Pseudupeneus maculatus	1	30.0	20.6	10.0	0.282
Rhomboplites aurorubens	2	19.5	22.0	9.4	0.542
Sargocentron bullisi	1	65.2	36.5	9.2	**0.006**
Schultzea beta	1	70.0	30.1	12.3	**0.007**
Scorpaenidae	2	12.7	21.8	10.4	0.762
Seriola rivoliana	1	18.6	25.0	11.6	0.537
Serranus annularis	1	73.4	37.1	10.4	**0.004**
Serranus phoebe	2	41.5	38.3	10.1	0.338
Serranus tortugarum	1	100.0	33.3	12.1	**0.001**
Sparisoma atomarium	1	87.8	37.3	10.8	**0.001**
Sphyaena barracuda	1	45.5	25.7	11.8	0.067
Stegastes partitus	1	97.5	34.5	11.3	**0.001**
Synodus spp.	2	19.8	22.8	11.0	0.542

Table 5. Mean and standard error for community parameters for sites in each cluster group. N equals sample size.

Cluster	Diversity		Evenness		No. Ind./Hr		No. Taxa/Hr		
Group	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**N**
1	1.651	0.169	0.584	0.046	598.7	245.4	24.2	2.1	10
2	1.715	0.226	0.723	0.089	229.2	99.5	17.2	4.3	5
3	1.095	0.159	0.370	0.044	456.0	128.8	22.8	3.2	6

Day-Night Comparison

The same 54 taxa used in the cluster analysis were used to compare indicator values for day- and night-sampled sites. All but one night-sampled sites were shallower than 85 m. To reduce the confounding effect of the deep sites that were identified as significantly different in the cluster analysis only cluster group 1 and 2 sites were used in the day-night comparison. Six taxa had significant indicator values (Table 6). All were most important in night samples. Only two of these taxa, *H. striatum* and *S. beta*, were common. Their greater abundance at night may due to a tendency to be closer to the bottom as an anti-predator mechanism, thus being more available the video survey method than during the day when they would tend to be further up in the water column.

Table 6. Taxa in the day-night comparison with significant indicator values. Maximum group indicates the period with the maximum indicator value and the observed indicator value (IV) for this period. Monte Carlo estimates of the mean indicator value for randomized groups and the standard deviation (SD) are used to determine the probability (P) that the observed value is greater than expected by chance alone for each taxon.

			Randomized Groups		
	Maximum	**Observed**	**IV**		
Taxon	**Group**	**IV**	**Mean**	**SD**	**P**
Diodon holocanthus	Night	45.4	21.5	8.8	0.036
Haemulon striatum	Night	73.3	42.5	13.4	0.023
Pseudupeneus maculatus	Night	49.7	20.9	9.5	0.038
Sargocentron bullisi	Night	71.0	48.1	12.0	0.048
Schultzea beta	Night	67.6	32.7	12.2	0.028
Scorpaenidae	Night	47.4	21.0	10.1	0.042

Discussion

While the Dry Tortugas represents the last emergent portion of the tropical Florida Keys, the southwest Florida shelf forms the corner of the Gulf of Mexico and Atlantic Ocean at the Straits of Florida. The area is bathed in the tropically derived Loop Current (Huh et al. 1981) (Figure 2). There are two components to the tropical fauna, continental and insular, in the western Atlantic (Robins 1971; Gilbert 1972). The southwest Florida shelf has ideal conditions for the interaction of these two faunas. The southern end of Pulley Ridge may be the deepest hermatypic coral community on the United States continental shelf (Halley et al. 2003). The fish assemblages have a distinct tropical flavor exemplified by *S. tortugarum* that is rarely found in other areas of the Gulf, but is common in the Dry Tortugas and Florida Keys (Longley and Hildebrand, 1941). Coral, per se, did not have a substantial influence on the fish assemblage, but the coralline algal nodule base that the hermatypic coral community grows on was very important.

The algal-nodule biotope on the middle to outer shelf has been described throughout the tropics (Reid and MacIntyre, 1988). At the Flower Gardens in the northwestern Gulf of Mexico it forms a distinctive Algal-sponge zone (Rezak et al., 1985) and the fish assemblage there is characterized by *C. enchrysura*, *C. argi* and *Serranus annularis* (Dennis and Bright, 1988). The Pulley Ridge fish assemblage is dominated by these same species, but differs in having more *S. beta*, *C. scotti*, and *S. partitus* that are either absent or at shallower depths further north. *Chromis enchrysura* is typically a member of the fish assemblage at this depth throughout the Gulf of Mexico (Dennis and Bright, 1988; Weaver et al., 2002). In the Florida Keys *Chromis enchrysura*, *C. scotti*, and *S. partitus*, are found in the deep-reef (45 m) habitat (Emery, 1973). The common presence of *S. partitus* down to 86 m and as deep as 123 m is a unique feature of the deep occurrence of algal nodules on Pulley Ridge. *Stegastes partitus* is the most common damselfish on emergent shelf-edge reefs in the Florida Keys (Emery, 1973). It is found the deepest of the shallow-water damselfishes because it does not have a foraging territory and relying on planktonic food sources (Ogden and Lobel, 1978). *Stegastes partitus* has been taken as deep as 73 m at the Dry Tortugas (Longley and Hildebrand, 1941), but only occasional below 45 m in the Algal-sponge zone at the Flower Gardens (Dennis and Bright, 1988).

Algal nodules are found down to 123 m at the SSE-146 site and *C. enchrysura* and *S. tortugarum* are apart of the fish fauna there. Algal nodules are restricted to about 90 m in the northwestern Gulf due to nepheloid layer (Rezak et al., 1990), but are known down to 200 m in the Bahamas (Littler et al., 1985). In the Bahamas *C. enchrysura* has been observed down to 140 m (Emery, 1973), but is not a dominant member of the wall fauna typical of the Caribbean (Colin, 1976; Dennis, in prep.). The deep occurrence of algal nodules at Pulley Ridge is a unique feature for the Gulf of Mexico allowing for the associated fish fauna to occur deeper here than elsewhere. Further research in the Caribbean may find this fish assemblage to occur as deep as algal nodules are found.

The algal nodules form a low-relief habitat. An important contributor to habitat structure in this biotope is excavation by fishes. *Malacanthus plumieri* is important rubble concentrator and mound builder in the Caribbean (Clifton and Hunter, 1972). Tilefish mounds are small, no more than 1-1.5 m wide and 0.5 m high, but important shelter for reef fishes in the Caribbean and Florida Keys including *C. enchrysura*, *C. scotti*, *C. argi*, *S. partitus*, and *S. tortugarum* (Colin 1973, Emery 1973). The same relationship between tilefish mounds and these species occurs on Pulley Ridge. These mounds contribute substantially to relief in the algal-nodule habitat on the southwest Florida shelf. In surveys at sites with numerous tilefish mounds the aggregation of fishes at mounds was striking. Few fish are seen on algal-nodule bottom between mounds. Tilefish mounds are loci of fish abundance and diversity in the relatively flat algal-nodule habitat.

The other putative biologically derived habitat feature is depressions within the algal-nodule habitat. These features, 1-5 m across and less than 1 m deep, add another scale of relief in this low-relief habitat. The depressions appear to be constructed by excavation of loose rubble and sand from around a rock outcrop or boulder. This forms a shelter for economically important fish species, such as *E. morio* and *Mycteroperca* spp. In addition to these large predators a host of smaller reef fishes use these depressions. The rock outcrops or just the depression slope attracts the same compliment of species using tilefish mounds. *Chromis enchrysura*, *C. insolata*, and *C. scotti* also use large depressions with rubble in the Florida Keys (Emery, 1973). These depressions are numerous and widespread on the southwest Florida shelf (R. Halley, USGS, St. Petersburg, Florida, pers. comm.).

The creator of these depressions is uncertain, as many fishes are known to burrow and substantially modify the bottom. These include tilefishes, *M. plumieri*, *Caulolatilus microps*, and *Lopholatilus chamaeleonticeps*, and groupers, *Epinephelus flavolimbatus* and *Mycteroperca microlepis* (Clifton and Hunter, 1972; Able et al., 1987; Able et al., 1993; Jones et al., 1989). All these species have been collected from the southwest Florida shelf, but most are found below the depths surveyed in this study (Nelson and Carpenter, 1968). *Epinephelus morio*, *Epinephelus niveatus*, and *E. flavolimbatus* were the most common species taken by longline from 73-110 m on the southwest Florida shelf (Prytherch, 1983). Jones et al. (1989) noted that *E. flavolimbatus* were more common that *E. niveatus* on rugged habitat on the west Florida shelf in contrast to their use of soft bottom habitat in the northwestern Gulf of Mexico. Of the two only *E. niveatus* was observed in this study and it was rare. *Mycteroperca phenax* was the most common grouper observed in this study followed by *E. morio*. All but one depression had a resident *E. morio* and most had one or more *Mycteroperca* spp. While both are important commercial and recreational species, *E. morio* is particularly important on the southwest Florida shelf, one of its areas of greatest abundance (Roe, 1976). The west Florida shelf has been a major *E. morio* fishing grounds for many years (Moe, 1969) that continues to used to the present day (Schirripa et al., 1999). Catch is greatest north and shallower than the Pulley Ridge area. Catch drops off substantially deeper than 60 m, but the largest fish are found in deeper water (Rivas, 1970). This species has been recognized for its ability to makes use of flat, low-relief limestone bottom perforated with holes (Bullock and Smith, 1991). Its presence in most depressions and widespread occurrence in the area suggests that *E. morio* is the most likely candidate for the depression creator and thus a major habitat modifier on the southwest Florida shelf.

Few red snapper (*Lutjanus* spp.) were observed in the study. This is in part due to their aversion of the undersea vehicles and in part to the depth of the features surveyed here. Red snapper stay at the edge of visibility so would not typically be counted in the surveys. In addition the snapper grounds in this area are shallower (<50 m) than the sites surveyed here even in their pre-exploited state (Collins, 1885). The middle to outer southwest Florida shelf does not appear important to snapper populations.

While the occurrence of high-relief hard bottom features is uncommon, where outcrops or ledges occur there is substantial fish diversity. The most distinctive fish on these features include *Apogon affinis*, *Equetus lanceolatus*, *Pareques iwamoti*, and *Pareques unmbrosus*. These same species are found on high-relief hard bottom features in the northern Gulf of Mexico (Dennis and Bright, 1988; Weaver et al., 2002).

The outer shelf reef fish assemblage identified in cluster group 3 is dominated by anthiins and *P. martinicensis* down to 120 m. Anthiines included at least three slender bodied species, *Anthias tenuis*, *Hemanthias aureorubens*, and *Hemanthias vivanus*, that can not reliably separated on video footage. This taxon may include juvenile *Hemanthias leptus* (longfin bass) that is known from the southwest Florida shelf-edge area (Bullock and Smith, 1991), but not identified in this study. This assemblage starts at about the same depth in the northern Gulf of Mexico (Dennis and Bright, 1988; Weaver et al., 2002) except where algal nodules occur. In the Caribbean slender anthiins are virtually absent and *P. martinicensis* is common down to 240 m (Colin, 1976; Dennis, in prep.). Below 120 m another reef fish assemblage develops characterized by *Antigonia capros*, *Ostichthys trachypoma*, *Plectranthias garrupellus*, *P. aya*, and *Prognathodes guayanensis* in addition to anthiins and *P. martinicensis*. These taxa with the except of *P. guayanensis* may comprise a continental outer shelf fauna. *Prognathodes guayanensis* is the Caribbean insular replacement for *P. aya* and represents a new record to the Gulf of Mexico (Hubbs, 1963). An another tropical insular species, Liopropoma aberrans was observed on these deep reefs. It and *P. guayanensis* have only recently been reported from U.S. continental waters (Quattrini et al., in press). Their occurrence here demonstrates a mixing of the tropical insular and continental faunas on the southwest Florida shelf.

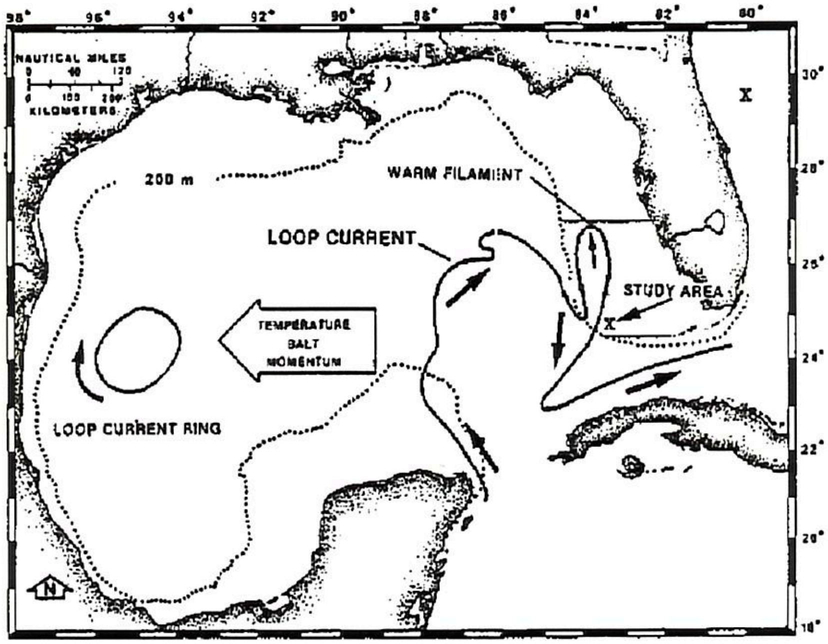

Figure 2. Southern Pulley Ridge, located at the X, is influenced by the Loop Current which bathes the area in warm, clear seawater from the Caribbean Sea.

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APPENDIX A

Fish taxa observed in video footage from 21 dives on the southwest Florida shelf listed by site and alphabetically by family and species.

Appendix Table A-1. Fish taxa observed in video footage from 21 dives on the southwest Florida shelf listed by site and alphabetically by family and species. P indicates present but not during survey time.

		Cluster Group	1	1	1	1	1	1	1
		Station	H/H 1	H/H 4	H/H 8	SSE-143	SSE-144	SSE-146	H/H 7
Family	**Taxon**	**Common Name Depth (m)**	72	71	72	84	85	123	42
Apogonidae	*Apogon affinis*	bigtooth cardinalfish							P
	Apogon pseudomaculatus	twospot cardinalfish	2	P			4	3	1
	Apogon spp.	cardinalfish							
Aulostomidae	*Aulostomus maculatus*	trumpetfish							
Balistidae	*Balistes capriscus*	gray triggerfish							
	Balistes vetula	queen triggerfish		P					
	Xanthichthys ringens	sargassum triggerfish							
Batrachoididae	Opsanus pardus	leopard toadfish							
Caproidae	*Antigonia capros*	deepbody boarfish							
Carangidae	carangids	jacks							
	Decapterus spp.	scad							
	Seriola dumerili	greater amberjack							
	Seriola rivoliana	Almaco jack							3
Carcharhinidae	carcharhinids	requiem shark				1	2		
Chaetodontidae	*Chaetodon ocellatus*	spotfin butterflyfish							
	Chaetodon sedentarius	reef butterflyfish	8	6	P	6	12	6	21
	Prognathodes aculeatus	longsnout butterflyfish			1				
	Prognathodes aya	bank butterflyfish							
	Prognathodes guyanensis	French butterflyfish							
Clupeidae	clupeids	herrings							
Diodontidae	*Diodon holocanthus*	balloonfish							1
Engraulidae	engraulids	anchovies							
Ginglymostomatidae	*Gingylostoma cirratum*	nurse shark							1
Gobiidae	gobiid	gobies					1		
Haemulidae	*Haemulon melanurum*	cottonwick							
	Haemulon striatum	striped grunt		P	P		51	22	41
	Haemulon spp.	grunts							
Holocentridae	*Corniger spinosus*	spinycheek soldierfish							1

Appendix Table A-1. Continued.

			Cluster Group	1	1	1	1	1	1	1
			Station	**H/H 1**	**H/H 4**	**H/H 8**	**SSE-143**	**SSE-144**	**SSE-146**	**H/H 7**
Family	**Taxon**	**Common Name**	**Depth (m)**	72	71	72	84	85	123	42
Holocentridae	*Holocentrus adscensionis*	squirrelfish			4					6
(continued)	*Holocentrus rufus*	longspine squirrelfish								
	holocentrid	squirrelfish		1						
	Myrpristis jacobus	blackbar soliderfish								P
	Neoniphon marinus	squirrelfish								
	Ostichthys trachypoma	bigeye soldierfish								
	Sargocentron bullisi	deepwater squirrelfish		2	P	6		8	3	6
Inermiidae	inermid	boga								
Labridae	*Bodianus pulchellus*	spotfin hogfish		4	P		1	1	2	3
	Decodon puellaris	red hogfish								
	Halichoeres bathyphilus	deepwater wrasse					2		2	
	Halichoeres garnoti	yellowhead wrasse			1					
	Halichoeres sp.	wrasse					1			
	labrid	wrasse								
	Lachnolaimus maximus	hogfish				P		1		1
	Xyrichthys spp.	razorfish								
Lutjanidae	*Lutjanus* sp.	snapper						4		
	Lutjanus analis	mutton snapper								
	Lutjanus campechanus	red snapper						5		P
	Lutjanus jocu	dog snapper								2
	Rhomboplites aurorubens	vermilion snapper								
Malacanthidae	*Caulolatilus cyanops*	blackline tilefish								
	Caulolatilus microps	blueline tilefish								
	Malacanthus plumieri	sand tilefish				P	1	1		1
Monacanthidae	*Monacanthus ciliatus*	fringed filefish								
	Monacanthus tuckeri	slender filefish								
Mullidae	*Pseudupeneus maculatus*	spotted goatfish				P		1		
Muraenidae	*Gymnothorax moringa*	spotted moray								1
	Muraena retifera	reticulate moray								

Appendix Table A-1. Continued.

			Cluster Group	1	1	1	1	1	1	1
			Station	**H/H 1**	**H/H 4**	**H/H 8**	**SSE-143**	**SSE-144**	**SSE-146**	**H/H 7**
Family	**Taxon**	**Common Name**	**Depth (m)**	72	71	72	84	85	123	42
Muraenidae	muraenid	moray								
Ogoccephalidae	*Ogcocephalus* spp.	batfish								
Ophichthidae	*Ophichthus ophis*	spotted snake eel								
Ostraciidae	*Acanthostracion* spp.	cowfish								
Peristediidae	*Peristedion* spp.	armored searobins								
Pomacanthidae	*Centropyge argi*	cherubfish		17	5	48	17	8	6	19
	Holacanthus bermudensis	blue angelfish				P	1		1	2
	Holacanthus tricolor	rock beauty		1	1	2		5	2	8
	Pomacanthus arcuatus	gray angelfish				P				
	Pomacanthus paru	French angelfish			P					
Pomacentridae	*Chromis cyanea*	blue chromis			P	2			1	30
	Chromis enchrysura	yellowtail reeffish		35	11	76	9	24	52	203
	Chromis insolata	sunshinefish		4		21			5	38
	Chromis scotti	purple reeffish		9	12	27		22	1	167
	Chromis spp.	damselfishes			20	14				100
	Stegastes partitus	bicolor damselfish		25	23	60	8	16	4	6
Priacanthidae	*Pristigenys alta*	short bigeye								
	Priacanthus arenatus	bigeye								
Rajidae	rajid	skate								
Scaridae	*Cryptotomus roseus*	slender parrtotfish					1			
Scaridae	*Sparisoma atomarium*	greenblotch parrotfish		3	5	6	1	2	1	13
Sciaenidae	*Equetus lanceolatus*	jack-knife fish								
	Pareques iwamoto	black-bar drum								
	Pareques umbrosus	cubbyu								
Scorpaenidae	Scorpaenidae	scorpionfishes								
Serranidae	*Anthias tenuis*	threadnose bass								
	anthiins	slender anthiins								
	Cephalopholis cruentata	graysby								1
	Cephalopholis fulva	coney								

Appendix Table A-1. Continued.

		Cluster Group	1	1	1	1	1	1	1
		Station	H/H 1	H/H 4	H/H 8	SSE-143	SSE-144	SSE-146	H/H 7
Family	**Taxon**	**Common Name Depth (m)**	72	71	72	84	85	123	42
Serranidae	*Epinephelus adscensionis*	rock hind							
(continued)	*Epinephelus drummondhayi*	speckled hind							
	Epinephelus guttatus	red hind		P					
	Epinephelus morio	red grouper		1	P			1	
	Epinephelus nigritus	Warsaw grouper							
	Epinephelus niveatus	snowy grouper							
	Epinephelus spp.	grouper							
	Gonioplectrus hispanus	Spanish flag							
	Hemanthias aureorubens	streamer bass							
	Hemanthias vivanus	red barbier							
	Liopropoma aberrans	rosy basslet							
	Liopropoma eukrines	wrasse bass		2	4		3	2	5
	Liopropoma sp.	basslet							
	Mycteroperca intertitialis	yellowmouth grouper		P					3
	Mycteroperca microlepis	gag							
	Mycteroperca phenax	scamp		P					
	Mycteroperca spp.	grouper					2		
	Paranthias furcifier	creole-fish			P		8		
	Plectranthias garrupellus	apricot bass							
	Pronotogrammus martinicensis	roughtongue bass							
	Schultzea beta	school bass					309	123	301
	Serranus annularis	orangeback bass	3	P	16		11	4	19
	Serranus notospilus	saddle bass							
	Serranus phoebe	tattler				1	3		2
	Serranus tigrinus	harlequin bass							
	Serranus tortugarum	chalk bass	12	23	270	147	91	62	12
Sparidae	*Calamus* spp.	porgy							
	Pagrus pagrus	red porgy							
Sphyraenidae	*Sphyaena barracuda*	greater barracuda			1		1		1

Appendix Table A-1. Continued.

			Cluster Group	1	1	1	1	1	1	1
			Station	H/H 1	H/H 4	H/H 8	SSE-143	SSE-144	SSE-146	H/H 7
Family	Taxon	Common Name	Depth (m)	72	71	72	84	85	123	42
Synodontidae	*Synodus* spp.	lizardfishes								
Tetraodontidae	*Canthigaster jamestyleri*	sharpnose puffer								
	Canthigaster rostrata	Atlantic sharpnose puffer			P		1			
	Canthigaster spp.	sharpnose puffer								
	Sphoeroides spengleri	bandtail puffer								
Triglidae	*Prionotus* spp.	sea robin								
		Total Survey Time (hrs)		1.46	1.69	2.38	1.73	3.04	1.57	1.36
		Total No. Individuals		126	114	554	198	596	303	1019
		No. Taxa		14	25	24	15	26	20	35
		Diversity		0.721	2.156	1.739	1.095	1.834	1.839	2.202
		Evenness		0.657	0.841	0.642	0.404	0.563	0.614	0.635

Appendix Table A-1. Continued.

		Cluster Group	1	1	1	2	2	2	2
		Station	SSE-69	SSE-66	SSE-67	H/H 2	SSE-141	SSE-68	H/H 3
Family	**Taxon**	**Common Name Depth (m)**	67	69	65	76	100	92	52
Apogonidae	*Apogon affinis*	bigtooth cardinalfish	113						
	Apogon pseudomaculatus	twospot cardinalfish	2						4
	Apogon spp.	cardinalfish				3	1		
Aulostomidae	*Aulostomus maculatus*	trumpetfish	1						
Balistidae	*Balistes capriscus*	gray triggerfish		1					
	Balistes vetula	queen triggerfish							
	Xanthichthys ringens	sargassum triggerfish							
Batrachoididae	*Opsanus pardus*	leopard toadfish					1		
Caproidae	*Antigonia capros*	deepbody boarfish							
Carangidae	carangids	jacks							27
	Decapterus spp.	scad	60				194		
	Seriola dumerili	greater amberjack							
	Seriola rivoliana	Almaco jack		26					
Carcharhinidae	carcharhinids	requiem shark							
Chaetodontidae	*Chaetodon ocellatus*	spotfin butterflyfish							
	Chaetodon sedentarius	reef butterflyfish	3	22	3	13	3		4
	Prognathodes aculeatus	longsnout butterflyfish		5	4				
	Prognathodes aya	bank butterflyfish							
	Prognathodes guyanensis	French butterflyfish							
Clupeidae	clupeids	herrings		14					
Diodontidae	*Diodon holocanthus*	balloonfish	1		1				
Engraulidae	engraulids	anchovies							
Ginglymostomatidae	*Gingylostoma cirratum*	nurse shark							
Gobiidae	gobiid	gobies		1		1			
Haemulidae	*Haemulon melanurum*	cottonwick							
	Haemulon striatum	striped grunt	129		523	50			P
	Haemulon spp.	grunts	1						
Holocentridae	*Corniger spinosus*	spinycheek soldierfish							

Appendix Table A-1. Continued.

		Cluster Group	1	1	1	2	2	2	2
		Station	SSE-69	SSE-66	SSE-67	H/H 2	SSE-141	SSE-68	H/H 3
Family	Taxon	Common Name Depth (m)	67	69	65	76	100	92	52
Holocentridae	*Holocentrus adscensionis*	squirrelfish		1					
(continued)	*Holocentrus rufus*	longspine squirrelfish		1	1				
	holocentrid	squirrelfish				1			
	Myrpristis jacobus	blackbar soliderfish							
	Neoniphon marinus	squirrelfish					5		
	Ostichthys trachypoma	bigeye soldierfish							
	Sargocentron bullisi	deepwater squirrelfish	6	4	1	1			
Inermiidae	inermid	boga				75			
Labridae	*Bodianus pulchellus*	spotfin hogfish		2		1	1		P
	Decodon puellaris	red hogfish				3	2		
	Halichoeres bathyphilus	deepwater wrasse		6		2	4	1	1
	Halichoeres garnoti	yellowhead wrasse					1		
	Halichoeres sp.	wrasse				1	1		
	labrid	wrasse				1			
	Lachnolaimus maximus	hogfish		1					1
	Xyrichthys spp.	razorfish							
Lutjanidae	*Lutjanus* sp.	snapper							
	Lutjanus analis	mutton snapper			1				
	Lutjanus campechanus	red snapper		3					
	Lutjanus jocu	dog snapper							
	Rhomboplites aurorubens	vermilion snapper	P				80		
Malacanthidae	*Caulolatilus cyanops*	blackline tilefish							
	Caulolatilus microps	blueline tilefish							
	Malacanthus plumieri	sand tilefish		1					
Monacanthidae	*Monacanthus ciliatus*	fringed filefish							
	Monacanthus tuckeri	slender filefish				1			
Mullidae	*Pseudupeneus maculatus*	spotted goatfish	2						
Muraenidae	*Gymnothorax moringa*	spotted moray							
	Muraena retifera	reticulate moray							

Appendix Table A-1. Continued.

		Cluster Group	1	1	1	2	2	2	2
		Station	SSE-69	SSE-66	SSE-67	H/H 2	SSE-141	SSE-68	H/H 3
Family	**Taxon**	**Common Name Depth (m)**	67	69	65	76	100	92	52
Muraenidae	muraenid	moray							
Ogoccephalidae	*Ogcocephalus* spp.	batfish							
Ophichthidae	*Ophichthus ophis*	spotted snake eel							
Ostraciidae	*Acanthostracion* spp.	cowfish		2		1			
Peristediidae	*Peristedion* spp.	armored searobins							
Pomacanthidae	*Centropyge argi*	cherubfish	3	44	7				
	Holacanthus bermudensis	blue angelfish				2			
	Holacanthus tricolor	rock beauty	5	8	2	2			
	Pomacanthus arcuatus	gray angelfish							
	Pomacanthus paru	French angelfish							
Pomacentridae	*Chromis cyanea*	blue chromis							
	Chromis enchrysura	yellowtail reeffish	75	84	8	85	34	1	
	Chromis insolata	sunshinefish	6	5		2			53
	Chromis scotti	purple reeffish	49	86	74	2			11
	Chromis spp.	damselfishes							50
	Stegastes partitus	bicolor damselfish	8	52	10	3			
Priacanthidae	*Pristigenys alta*	short bigeye				1	2		
	Priacanthus arenatus	bigeye		P		2			
Rajidae	rajid	skate							
Scaridae	*Cryptotomus roseus*	slender parrtotfish							
Scaridae	*Sparisoma atomarium*	greenblotch parrotfish	8	16	9	1			
Sciaenidae	*Equetus lanceolatus*	jack-knife fish				9	10		
	Pareques iwamoto	black-bar drum							
	Pareques umbrosus	cubbyu							
Scorpaenidae	Scorpaenidae	scorpionfishes	1						
Serranidae	*Anthias tenuis*	threadnose bass							
	anthiins	slender anthiins			14				
	Cephalopholis cruentata	graysby			2				
	Cephalopholis fulva	coney				1			

Appendix Table A-1. Continued.

		Cluster Group	1	1	1	2	2	2	2
		Station	SSE-69	SSE-66	SSE-67	H/H 2	SSE-141	SSE-68	H/H 3
Family	**Taxon**	**Common Name** Depth (m)	67	69	65	76	100	92	52
Serranidae	*Epinephelus adscensionis*	rock hind							
(continued)	*Epinephelus drummondhayi*	speckled hind							
	Epinephelus guttatus	red hind							
	Epinephelus morio	red grouper	1		1	2	1		1
	Epinephelus nigritus	Warsaw grouper							
	Epinephelus niveatus	snowy grouper							
	Epinephelus spp.	grouper							
	Gonioplectrus hispanus	Spanish flag							
	Hemanthias aureorubens	streamer bass							
	Hemanthias vivanus	red barbier							
	Liopropoma aberrans	rosy basslet							
	Liopropoma eukrines	wrasse bass	2	3	P	3	2	1	1
	Liopropoma sp.	basslet							
	Mycteroperca intertitialis	yellowmouth grouper							
	Mycteroperca microlepis	gag							
	Mycteroperca phenax	scamp	1	1					
	Mycteroperca spp.	grouper							
	Paranthias furcifier	creole-fish							
	Plectranthias garrupellus	apricot bass							
	Pronotogrammus martinicensis	roughtongue bass							
	Schultzea beta	school bass	233	603	1446				
	Serranus annularis	orangeback bass	7	20	7	4			1
	Serranus notospilus	saddle bass				1			
	Serranus phoebe	tattler	2	2	3	11	6	P	1
	Serranus tigrinus	harlequin bass			2				
	Serranus tortugarum	chalk bass	31	166	3				
Sparidae	*Calamus* spp.	porgy	1			2			
	Pagrus pagrus	red porgy							
Sphyraenidae	*Sphyaena barracuda*	greater barracuda		1	2				P

Appendix Table A-1. Continued.

			Cluster Group	**1**	**1**	**1**	**2**	**2**	**2**	**2**
			Station	**SSE-69**	**SSE-66**	**SSE-67**	**H/H 2**	**SSE-141**	**SSE-68**	**H/H 3**
Family	**Taxon**	**Common Name**	**Depth (m)**	67	69	65	76	100	92	52
Synodontidae	*Synodus* spp.	lizardfishes		3	1				P	
Tetraodontidae	*Canthigaster jamestyleri*	sharpnose puffer								
	Canthigaster rostrata	Atlantic sharpnose puffer		1			2			
	Canthigaster spp.	sharpnose puffer								
	Sphoeroides spengleri	bandtail puffer								
Triglidae	*Prionotus* spp.	sea robin								
		Total Survey Time (hrs)		1.15	1.06	0.83	1.66	0.64	0.12	0.42
		Total No. Individuals		755	1182	2124	289	348	3	155
		No. Taxa		29	31	23	32	17	5	15
		Diversity		2.137	1.838	0.948	2.179	1.406	1.099	1.608
		Evenness		0.641	0.540	0.307	0.629	0.496	1.000	0.647

Appendix Table A-1. Continued.

		Cluster Group	2	3	3	3	3	3	3
		Station	SSE-63	H/H 5	H/H 6	SSE-64	SSE-145	SSE-65	SSE-62
Family	**Taxon**	**Common Name Depth (m)**	72	108	178	180	114	86	82
Apogonidae	*Apogon affinis*	bigtooth cardinalfish					1		
	Apogon pseudomaculatus	twospot cardinalfish	P					4	5
	Apogon spp.	cardinalfish		2					
Aulostomidae	*Aulostomus maculatus*	trumpetfish						P	
Balistidae	*Balistes capriscus*	gray triggerfish							
	Balistes vetula	queen triggerfish							
	Xanthichthys ringens	sargassum triggerfish		1					
Batrachoididae	*Opsanus pardus*	leopard toadfish							
Caproidae	*Antigonia capros*	deepbody boarfish			1	9			
Carangidae	carangids	jacks							
	Decapterus spp.	scad							
	Seriola dumerili	greater amberjack						P	
	Seriola rivoliana	Almaco jack				1		P	
Carcharhinidae	carcharhinids	requiem shark							
Chaetodontidae	*Chaetodon ocellatus*	spotfin butterflyfish							2
	Chaetodon sedentarius	reef butterflyfish	2	30			8		17
	Prognathodes aculeatus	longsnout butterflyfish							
	Prognathodes aya	bank butterflyfish		2	13	2	3		2
	Prognathodes guyanensis	French butterflyfish				1			
Clupeidae	clupeids	herrings							
Diodontidae	*Diodon holocanthus*	balloonfish							
Engraulidae	engraulids	anchovies		P					
Ginglymostomatidae	*Gingylostoma cirratum*	nurse shark							
Gobiidae	gobiid	gobies	12	1					
Haemulidae	*Haemulon melanurum*	cottonwick							3
	Haemulon striatum	striped grunt							
	Haemulon spp.	grunts							
Holocentridae	*Corniger spinosus*	spinycheek soldierfish							6

Appendix Table A-1. Continued.

Family	Taxon	Common Name	Cluster Group / Station / Depth (m)	2 SSE-63 72	3 H/H 5 108	3 H/H 6 178	3 SSE-64 180	3 SSE-145 114	3 SSE-65 86	3 SSE-62 82
Holocentridae	*Holocentrus adscensionis*	squirrelfish			3			2		
(continued)	*Holocentrus rufus*	longspine squirrelfish							1	
	holocentrid	squirrelfish			1			1		
	Myrpristis jacobus	blackbar soliderfish								
	Neoniphon marinus	squirrelfish			1					
	Ostichthys trachypoma	bigeye soldierfish					8			
	Sargocentron bullisi	deepwater squirrelfish		1	1	3		1		
Inermiidae	inermid	boga								
Labridae	*Bodianus pulchellus*	spotfin hogfish								6
	Decodon puellaris	red hogfish			1	13	2	1		
	Halichoeres bathyphilus	deepwater wrasse				7		2		36
	Halichoeres garnoti	yellowhead wrasse								
	Halichoeres sp.	wrasse			1					
	labrid	wrasse								
	Lachnolaimus maximus	hogfish								4
	Xyrichthys spp.	razorfish		1						
Lutjanidae	*Lutjanus* sp.	snapper						1		
	Lutjanus analis	mutton snapper								
	Lutjanus campechanus	red snapper					1			3
	Lutjanus jocu	dog snapper								
	Rhomboplites aurorubens	vermilion snapper					4			
Malacanthidae	*Caulolatilus cyanops*	blackline tilefish					P			
	Caulolatilus microps	blueline tilefish					1			
	Malacanthus plumieri	sand tilefish						3		
Monacanthidae	*Monacanthus ciliatus*	fringed filefish		1						
	Monacanthus tuckeri	slender filefish							1	
Mullidae	*Pseudupeneus maculatus*	spotted goatfish								
Muraenidae	*Gymnothorax moringa*	spotted moray						1		
	Muraena retifera	reticulate moray					1			

Appendix Table A-1. Continued.

		Cluster Group	2	3	3	3	3	3	3
		Station	SSE-63	H/H 5	H/H 6	SSE-64	SSE-145	SSE-65	SSE-62
Family	**Taxon**	**Common Name** Depth (m)	72	108	178	180	114	86	82
Muraenidae	muraenid	moray				1			
Ogoccephalidae	*Ogcocephalus* spp.	batfish	1						
Ophichthidae	*Ophichthus ophis*	spotted snake eel		1					
Ostraciidae	*Acanthostracion* spp.	cowfish	1						
Peristediidae	*Peristedion* spp.	armored searobins	1						
Pomacanthidae	*Centropyge argi*	cherubfish	P				2		
	Holacanthus bermudensis	blue angelfish					2		8
	Holacanthus tricolor	rock beauty							
	Pomacanthus arcuatus	gray angelfish							
	Pomacanthus paru	French angelfish							
Pomacentridae	*Chromis cyanea*	blue chromis							
	Chromis enchrysura	yellowtail reeffish		36			6		
	Chromis insolata	sunshinefish							
	Chromis scotti	purple reeffish						2	8
	Chromis spp.	damselfishes							
	Stegastes partitus	bicolor damselfish							
Priacanthidae	*Pristigenys alta*	short bigeye	2		11	3			
	Priacanthus arenatus	bigeye					1		
Rajidae	rajid	skate					1		
Scaridae	*Cryptotomus roseus*	slender parrtotfish							
Scaridae	*Sparisoma atomarium*	greenblotch parrotfish	2				1		
Sciaenidae	*Equetus lanceolatus*	jack-knife fish	1						29
	Pareques iwamoto	black-bar drum				2			
	Pareques umbrosus	cubbyu							65
Scorpaenidae	Scorpaenidae	scorpionfishes	2		1				1
Serranidae	*Anthias tenuis*	threadnose bass			P				P
	anthiins	slender anthiins		123	117	3	453	123	1191
	Cephalopholis cruentata	graysby		1			1		
	Cephalopholis fulva	coney							

Appendix Table A-1. Continued.

		Cluster Group	2	3	3	3	3	3	3
		Station	SSE-63	H/H 5	H/H 6	SSE-64	SSE-145	SSE-65	SSE-62
Family	**Taxon**	**Common Name Depth (m)**	72	108	178	180	114	86	82
Serranidae	*Epinephelus adscensionis*	rock hind							1
(continued)	*Epinephelus drummondhayi*	speckled hind				1			4
	Epinephelus guttatus	red hind							
	Epinephelus morio	red grouper		1			2		1
	Epinephelus nigritus	Warsaw grouper							1
	Epinephelus niveatus	snowy grouper			2				
	Epinephelus spp.	grouper				1			
	Gonioplectrus hispanus	Spanish flag							6
	Hemanthias aureorubens	streamer bass				P			
	Hemanthias vivanus	red barbier			P			P	P
	Liopropoma aberrans	rosy basslet				P			
	Liopropoma eukrines	wrasse bass			5	1	2	P	4
	Liopropoma sp.	basslet			1				
	Mycteroperca intertitialis	yellowmouth grouper							
	Mycteroperca microlepis	gag							1
	Mycteroperca phenax	scamp			4	13	5	1	25
	Mycteroperca spp.	grouper				1	13		1
	Paranthias furcifier	creole-fish						2	7
	Plectranthias garrupellus	apricot bass			7				
	Pronotogrammus martinicensis	roughtongue bass		71	482	165	136	P	124
	Schultzea beta	school bass							
	Serranus annularis	orangeback bass		1			2		
	Serranus notospilus	saddle bass							
	Serranus phoebe	tattler		4	1		2		15
	Serranus tigrinus	harlequin bass							
	Serranus tortugarum	chalk bass							
Sparidae	*Calamus* spp.	porgy							1
	Pagrus pagrus	red porgy							2
Sphyraenidae	*Sphyaena barracuda*	greater barracuda							

Appendix Table A-1. Continued.

Family	Taxon	Common Name	Cluster Group / Station / Depth (m)	2	3	3	3	3	3	3
			Station	SSE-63	H/H 5	H/H 6	SSE-64	SSE-145	SSE-65	SSE-62
			Depth (m)	72	108	178	180	114	86	82
Synodontidae	*Synodus* spp.	lizardfishes		3						5
Tetraodontidae	*Canthigaster jamestyleri*	sharpnose puffer						2		1
	Canthigaster rostrata	Atlantic sharpnose puffer							P	17
	Canthigaster spp.	sharpnose puffer								6
	Sphoeroides spengleri	bandtail puffer		2						
Triglidae	*Prionotus* spp.	sea robin		1						
		Total Survey Time (hrs)		0.88	1.05	2.25	1.16	1.13	0.32	1.65
		Total No. Individuals		33	282	668	221	655	134	1608
		No. Taxa		17	20	17	23	27	14	36
		Diversity		2.283	1.609	1.005	1.197	1.101	0.419	1.237
		Evenness		0.843	0.547	0.371	0.399	0.334	0.215	0.351

APPENDIX B.

Fish data from the middle and outer southwest Florida shelf
from the MMS Southwest Florida Ecosystem Study summarized by gear and area.

Appendix Table B-1. Fish data from the middle and outer southwest Florida shelf from the MMS Southwest Florida Ecosystem Study summarized by gear and area. Data for otter trawl and triangle dredge from Woodward Clyde Consultants and Continental Shelf Associates (1985) and video survey data from Environmental Science and Engineering, Inc., LGL Ecological Research Associates, Inc., and Continental Shelf Associates, Inc. (1987). Sample size (N) equals the number of hauls for dredge and trawl and number of hectares surveyed for video data.

	Otter Trawl			**Triangle Dredge**			**Video Survey**	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Acanthostracion polygonius	2	0	2					
Acanthostracion quadricornis	2	0	2	1	0	1	0.1	
Acanthostracion spp.							0.2	
Aluterus schoepfii	0	4	4					
Amblycirrhius pinos	1	0	1					
Anarchias yoshiae	2	0	2	5	0	5		
Antennarius ocellatus	1	1	2	1	0	1		
Antennarius radiosus	1	6	7	0	2	2		
Anthiines							200.9	130.1
Anthias spp.								7.2
Antigonia capros	0	24	24	0	3	3		
Apogon affinis	2	0	2					
Apogon aurolineatus				3	0	3		
Apogon maculatus	68	0	68					
Apogon phenax	1	0	1					
Apogon pillionatus	19	1	20	1	0	1		
Apogon pseudomaculatus	68	0	68				0.1	
Aulostomus maculatus	2	0	2					

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	Outer	TOTAL	Middle	Outer	TOTAL	Middle	Outer
N =	16	8	24	15	8	23	122.18	34.83
Taxon	No.	No.	No.	No.	No.	No.	No./ha	No./ha
Balistes capriscus							0.5	
Bellator brachychir	1	0	1					
Bellator egretta	0	3	3	1	4	5		
Bellator militaris	0	1	1					
Bodianus pulchellus	3	0	3				4.9	
Bodianus rufus	0	11	11					
BOTHIDAE								0.3
Bothus robinsi	1	0	1	1	0	1		
Bregmaceros atlanticus	1	1	2	0	3	3		
Calamus calamus	2	0	2					
Calamus proridens	1	0	1					
Calamus spp.							0.6	
Canthigaster rostrata	5	0	5					
CARANGIDAE								
Centropristis ocyurus	3	0	3					
Centropyge argi	2	0	2	2	0	2		
Cephalophlis fulva							0.1	
Chaetodon aculeatus	3	0	3					
Chaetodon aya	0	1	1					
Chaetodon ocellatus	4	1	5	3	0	3	0.3	
Chaetodon sedentarius	21	0	21	1	0	1	10.7	0.3
Chilomycterus schoepfii	3	0	3					

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Chriolepis sp.				2	0	2		
Chromis cyanea	2	0	2					
Chromis enchrysura	120	0	120	5	0	5	384.7	
Chromis insolata							1.4	
Chromis scotti	70	0	70	5	0	5	73.4	
Chromis spp.							1.0	
Citharichthys cornutus	0	8	8					
Citharichthys gymnorhinus	1	0	1	1	0	1		
Citharichthys sp.	2	0	2					
Clepticus parrae	1	0	1					
Cosmocampus albirostris	1	0	1					
Cosmocampus sp.				1	0	1		
Cryptotomus roseus	2	0	2					
Decapterus spp.							409.2	
Decodon puellaris	0	3	7					
DIODONTIDAE							0.1	
Diodon holacanthus	2	0	2					
Diplectrum formosum	1	0	1					
Diplogrammus pauciradiatus				1	1	2		
Epigonus sp.	0	5	5					
Epinephelus morio							1.4	

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Equetus lanceolatus							5.5	
Ginglymostoma cirratum							0.1	
Gnatholepis thompsoni				1	0	1		
Gymnothorax nigromarginatus	11	0	11					
Haemulon plumierii	1	0	1					
Haemulon striatum	15	0	15					
Halichoeres caudalis							0.1	
Halichoeres poeyi	1	0	1					
Halichoeres spp.							9.8	
Halieutichthys aculeatus	15	19	34	4	3	7		
Hemanthias vivanus	0	14	14	0	1	1		
Hemicaranx amblyrhynchus	0	2	2					
Heteropriacanthus cruentatus							0.2	
Hippocampus erectus	21	0	21	4	0	4		
Hippocampus reidi	1	0	1	1	0	1		
Holacanthus bermudensis	1	2	3				2.2	
Holacanthus ciliaris							0.2	
Holacanthus spp.							0.2	
Holacanthus tricolor	3	0	3				2.8	
Holocentrus rufus	15	0	15				0.1	0.3
Holocentrus spp.							0.4	

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	Outer	TOTAL	Middle	Outer	TOTAL	Middle	Outer
N =	16	8	24	15	8	23	122.18	34.83
Taxon	No.	No.	No.	No.	No.	No.	No./ha	No./ha
Hoplunnis tenuis	2	0	2					
Hypoplectrus puella	0	1	1					
Hypoplectrus spp.							0.1	
Inermia vittata							54.8	
Lepophidium cervinum				0	1	1		
Liopropoma eukrines	2	0	2				0.2	
Lipogramma sp.				1	0	1		
Lophius gastrophysus	0	1	1					
Lutjanus synagris	1	0	1					
Lutjanus spp.							0.3	
Macrorhamphosus scolopax	0	1	1					
Malacanthus plumierii								0.3
Monacanthus ciliatus	96	1	97	16	0	16		
MULLIDAE								0.3
Mycteroperca phenax							0.2	
Mycteroperca spp.							3.1	0.6
Myropristis jacobus	0	3	3					
Neobythites sp.	0	2	2					
Neomerinthe beanorum	1	0	1					
Ogcocephalus corniger	1	4	5	0	1	1		0.6
Ogcocephalus declivirostris	4	0	4	1	0	1		

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Ogcocephalus parvus	2	0	2	0	1	1		
Ophidion beani	1	1	2					
Ophidion dromio	15	1	16					
Opistognathus lonchurus	1	0	1	1	0	1		
Opsanus pardus	3	0	3	2	1	3		
Ostichthys trachypoma	0	7	7					
Paradiplogrammus bairdi	1	0	1					
Parahollardia lineata	0	3	3	0	1	1		
Pareques umbrosus							0.2	
Physiculus fulvus	0	16	16					
Physiculus sp.	0	6	6					
Plectranthias garrupellus	0	38	38	0	2	2		
Pomacanthus arcuatus							0.5	
Pontinus castor	2	0	2					
Pontinus rathbuni	3	38	41	0	8	8		
Porichthys plectrodon	20	0	20	1	0	1		
Priacanthus arenatus							0.1	0.9
Prionotus alatus	6	0	6	3	0	3		
Prionotus roseus				1	0	1		
Prionotus stearnsi	0	14	14					
Pristigenys alta	5	3	8	1	0	1		

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Prognathodes aculeatus							0.2	
Prognathodes aya								5.5
Pronotogrammus martinicensis	0	26	26					0.3
Pseudogramma bermudensis				1	0	1		
Pseudupeneus maculatus	1	0	1					
Raja sp.	0	2	2					
Rhomboplites aurorubens	1	0	1					
Rypticus bistrispinus	12	2	14	3	4	7		
Sargocentron bullisi	59	0	59	1	0	1		
Saurida brasiliensis	4	8	12					
Saurida sp.	0	1	1					
Schultzea beta	315	1	316	1	0	1		
Scorpaena agassizi	35	6	41	4	0	4		
Scorpaena brachyptera	3	0	3	0	3	3		
Scorpaena brasiliensis	4	0	4	3	0	3		
Scorpaena dispar	48	7	55	8	0	8		
Scorpaena elachys	4	0	4					
Scorpaena sp.	50	0	50	3	0	3		0.9
Scyliorhinus retifer	0	1	1					
Seriola dumerili							3.0	
Serranus annularis	21	0	21	2	0	2	0.3	

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	Outer	TOTAL	Middle	Outer	TOTAL	Middle	Outer
N =	16	8	24	15	8	23	122.18	34.83
Taxon	No.	No.	No.	No.	No.	No.	No./ha	No./ha
Serranus atrobranchus	63	0	63					0.9
Serranus chionaria	13	0	13	3	0	3		
Serranus notospilus	61	38	99	3	2	5		
Serranus phoebe	164	22	186	3	0	3	11.9	10.6
Serranus subligarius	4	0	4					
Serranus tortugarum	35	0	35	6	0	6		
Serranus spp.							30.5	2.6
Sparisoma atomarium	83	0	83	8	0	8		
Sparisoma sp.	1	0	1					
Sphoeroides dorsalis	7	0	7					
Sphoeroides spengleri	6	0	6					
Starksia sp.	2	0	2	1	0	1	0.1	
Stegastes partitus	2	7	9	3	0	3	6.9	
Stegastes variabilis	4	0	4				2.1	
Stephanolepis hispidus	3	0	3					
Stephanolepis setifer	3	1	4					
Syacium papillosum	26	1	27	4	0	4		
Syacium sp.	1	0	1					
Symphurus sp.	0	1	1					
Synagrops bellus	0	1	1	0	1	1		
Syngnathus elucens	1	0	1	1	0	1		

Appendix Table B-1. Continued.

	Otter Trawl			Triangle Dredge			Video Survey	
	Middle	**Outer**	**TOTAL**	**Middle**	**Outer**	**TOTAL**	**Middle**	**Outer**
N =	**16**	**8**	**24**	**15**	**8**	**23**	**122.18**	**34.83**
Taxon	**No.**	**No.**	**No.**	**No.**	**No.**	**No.**	**No./ha**	**No./ha**
Synodus foetens				1	1	2		
Synodus intermedius	30	4	34	2	0	2		0.3
Synodus poeyi	37	9	46					7.5
Synodus synodus	5	0	5					
Synodus spp.								4
Trachinocephalus myops	3	1	4					0.3
Urophycis floridanus	8	4	12					
Varicus marilynae	1	1	2	4	0	4		

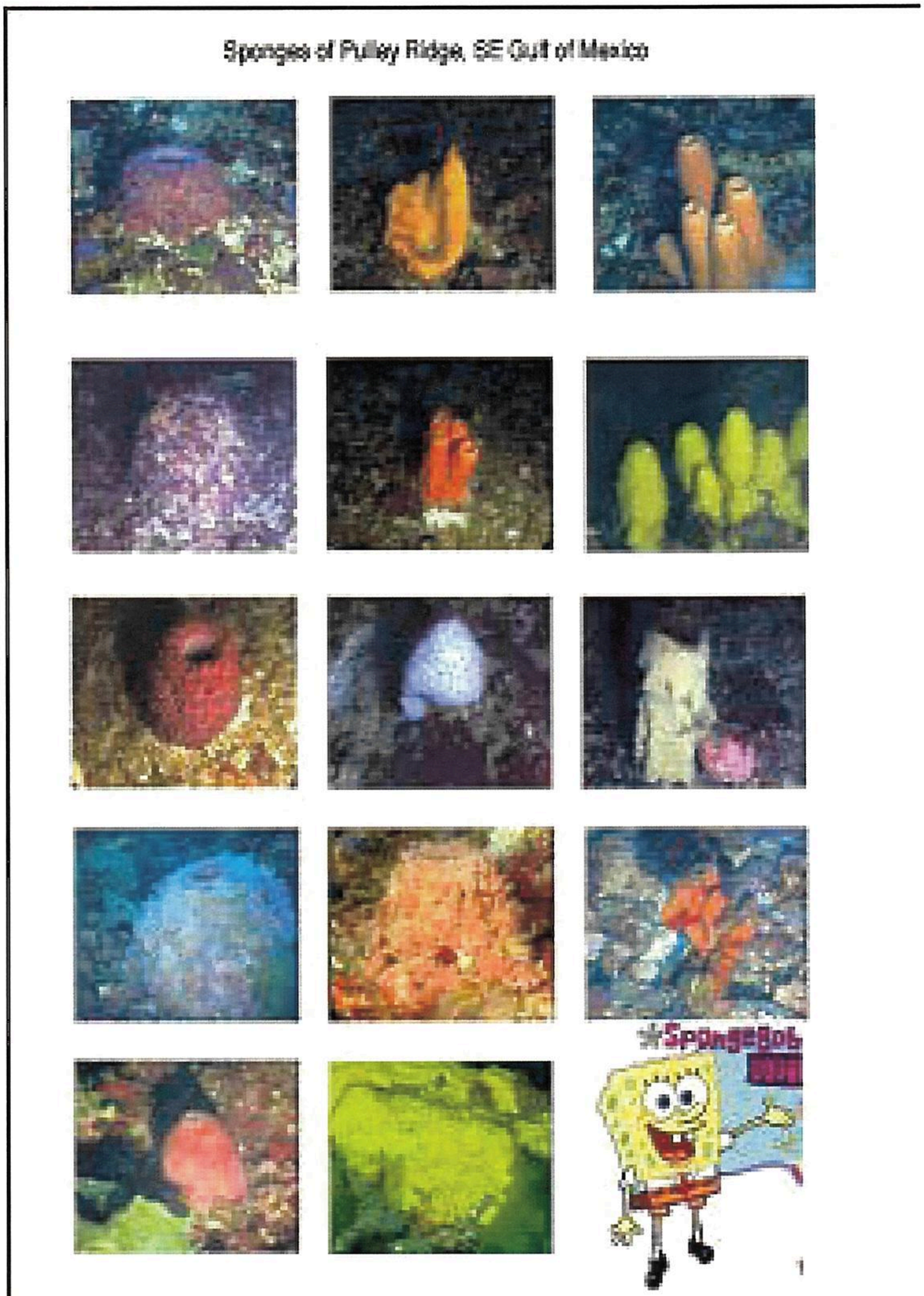

Figure 4. Sponges of Pulley Ridge

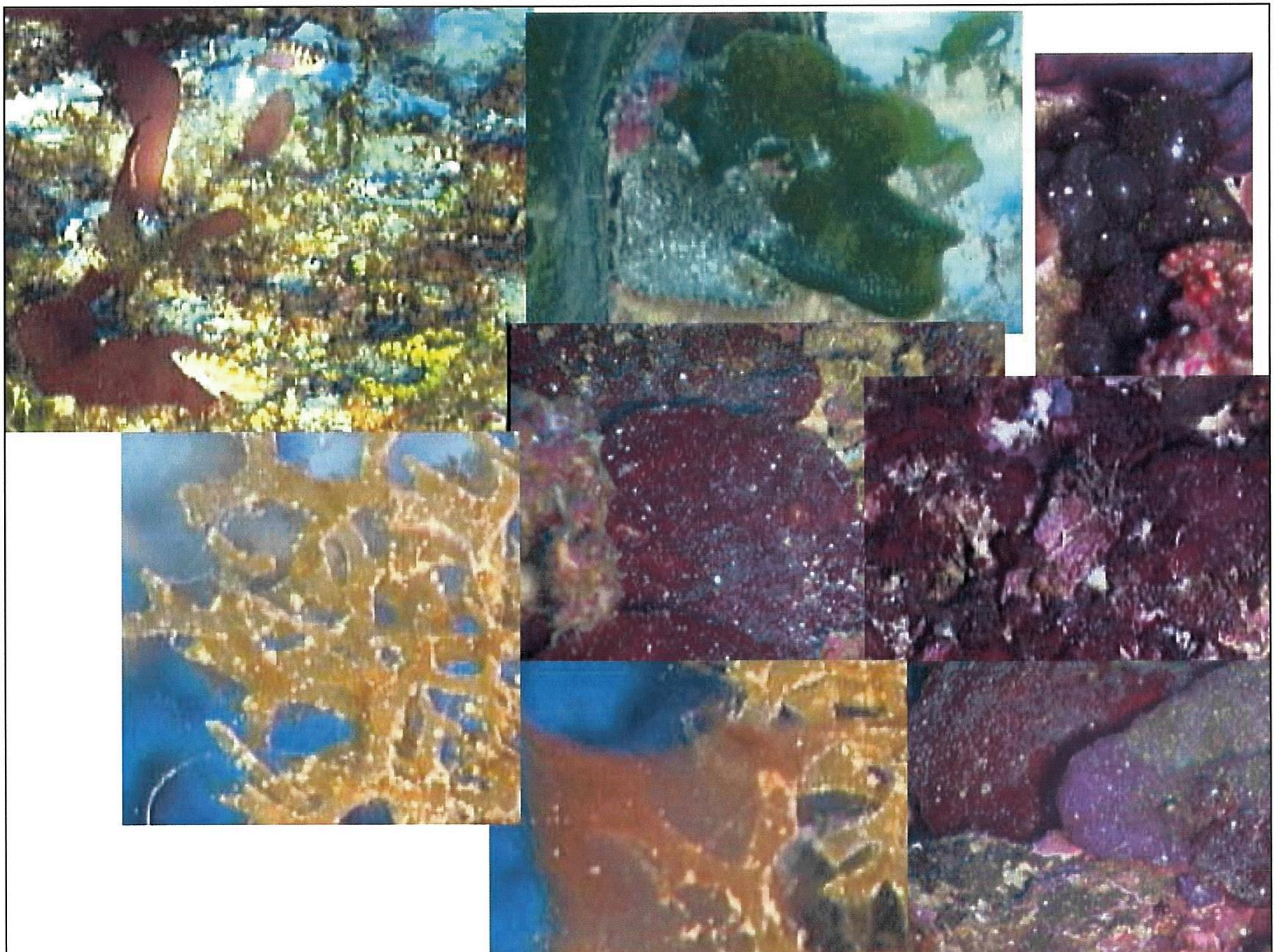

Figure 5. Pulley Ridge algae

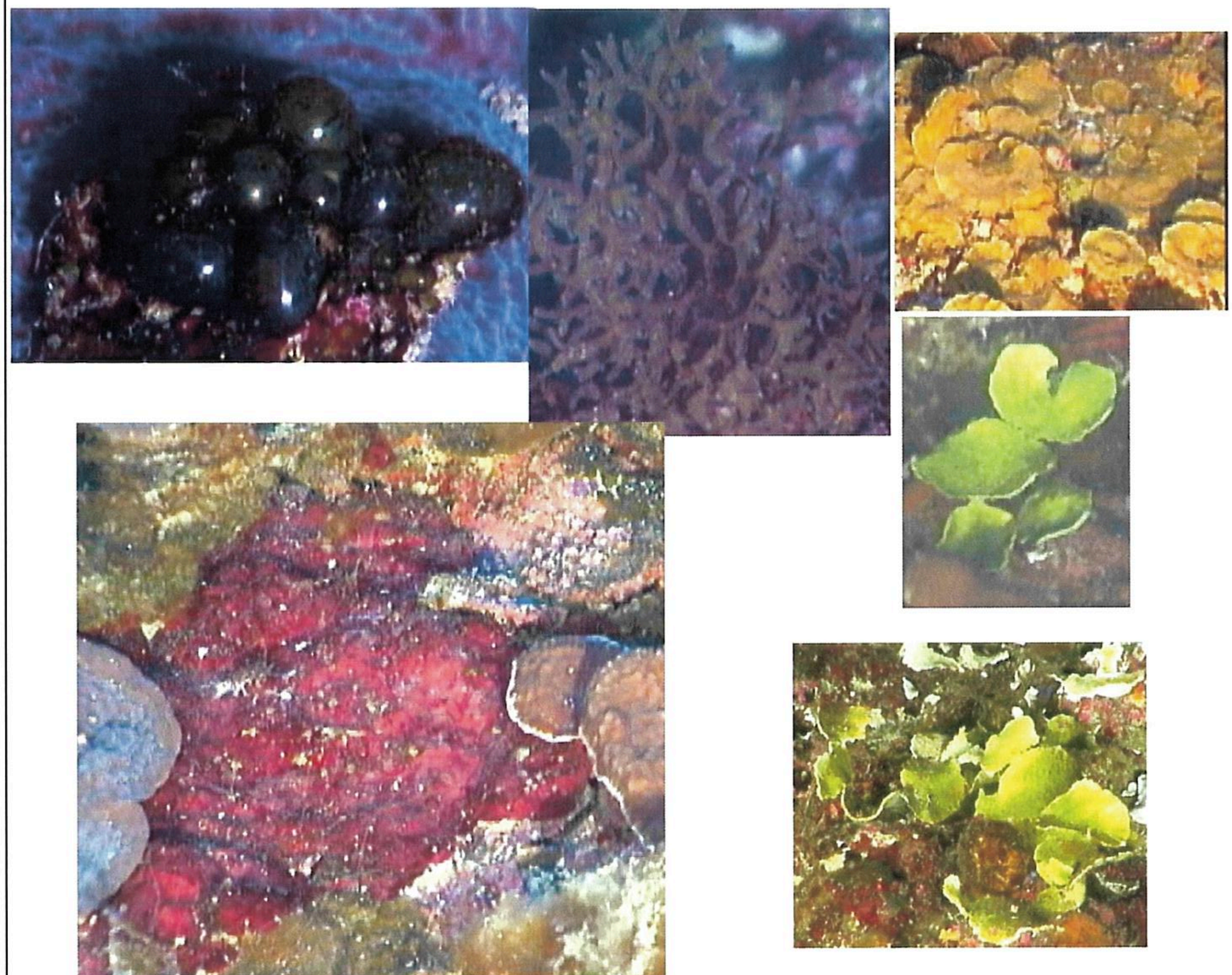

Figure 6. Pulley Ridge algae (cont)

Figure 7. Coral. (Agaricia sp. And Leptoceris sp.)

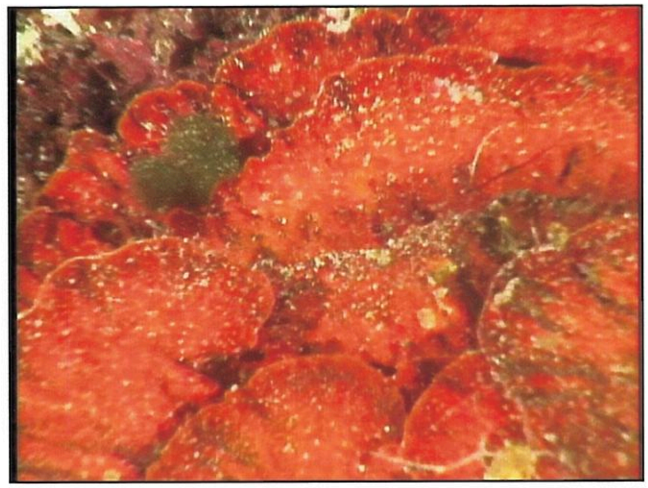

Figure 8. Coralline algae

Figure 9. Coral (Agaricia sp. And Madracis sp.).

Figure 10. Coral. (Agaricia sp. And Leptoceris sp.)

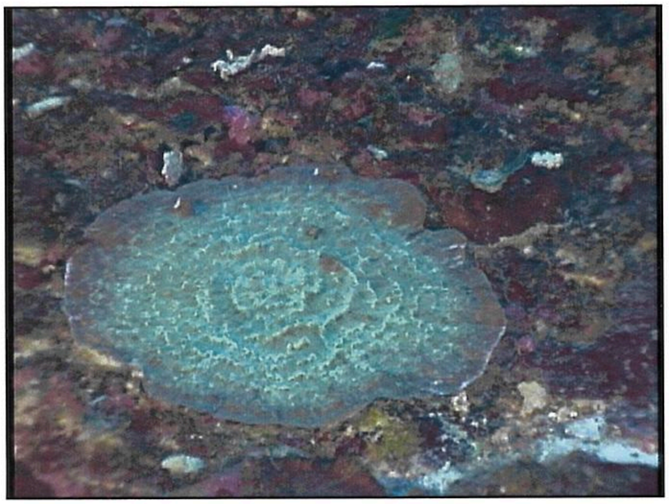

Figure 1. Agaricia undata coral at Pulley Ridge

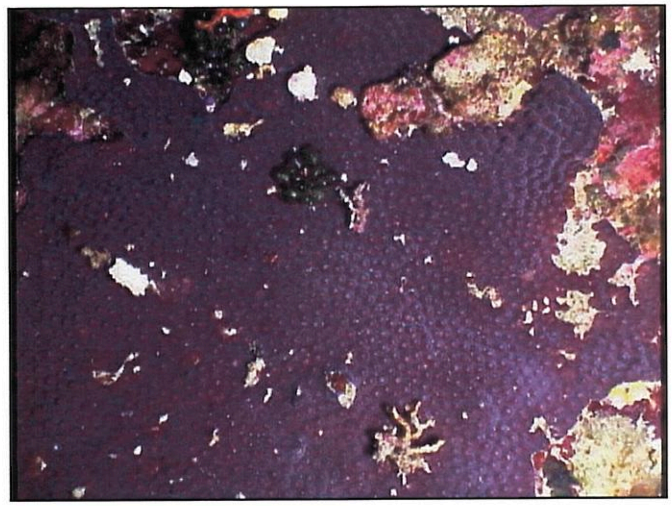

Figure 12. Coral. (Montastrea cavernosa).

Figure 3. Coral cover on southern Pulley Ridge

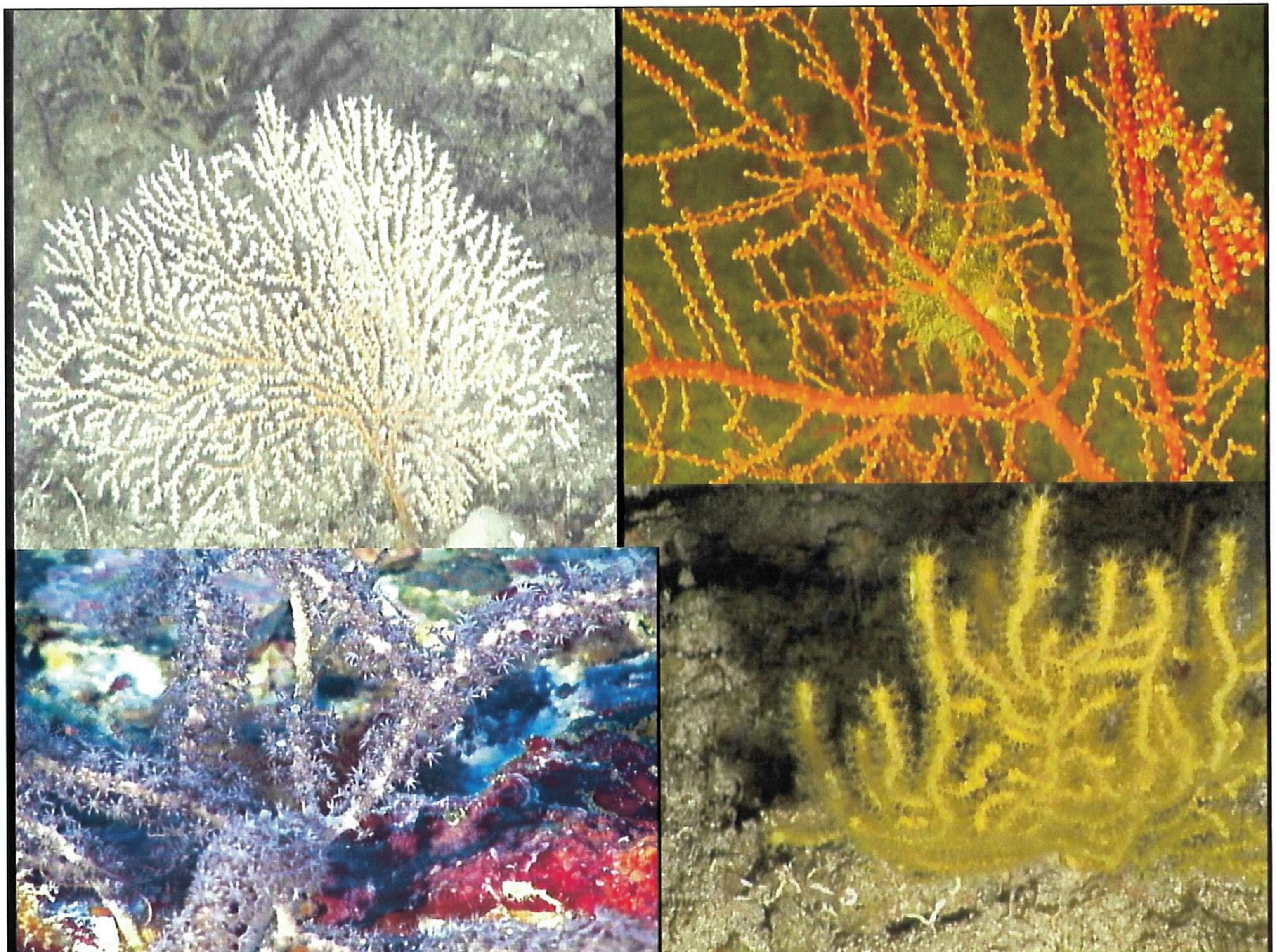

Figure 14 Pulley Ridge Octocorals

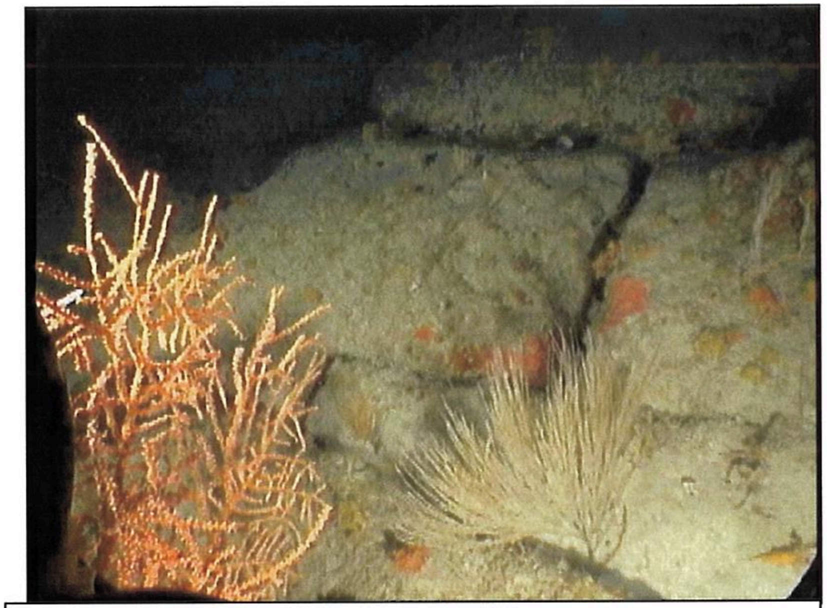

Figure 15 Beach rock from Pulley Ridge. Water depth = 60 m

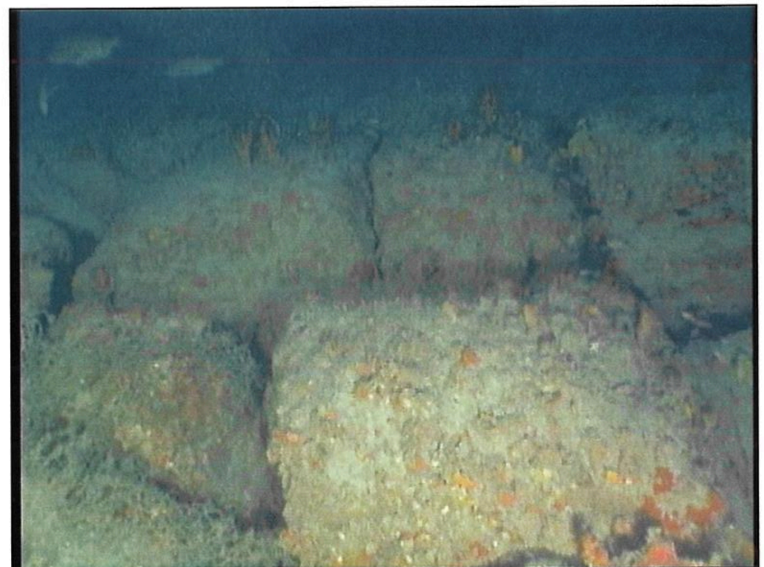

Figure 15. Beach rock at Pulley Ridge. Depth 60 m